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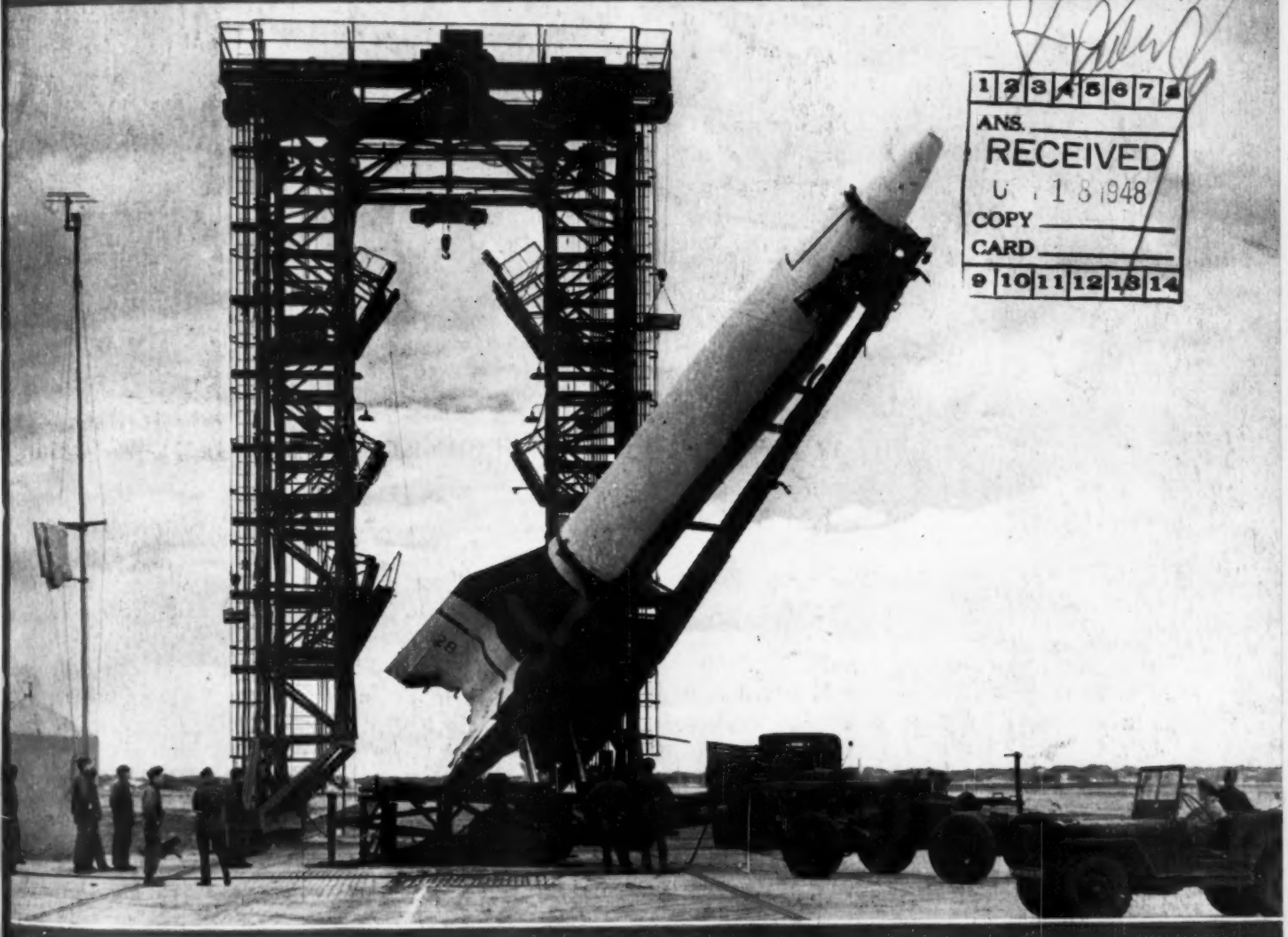

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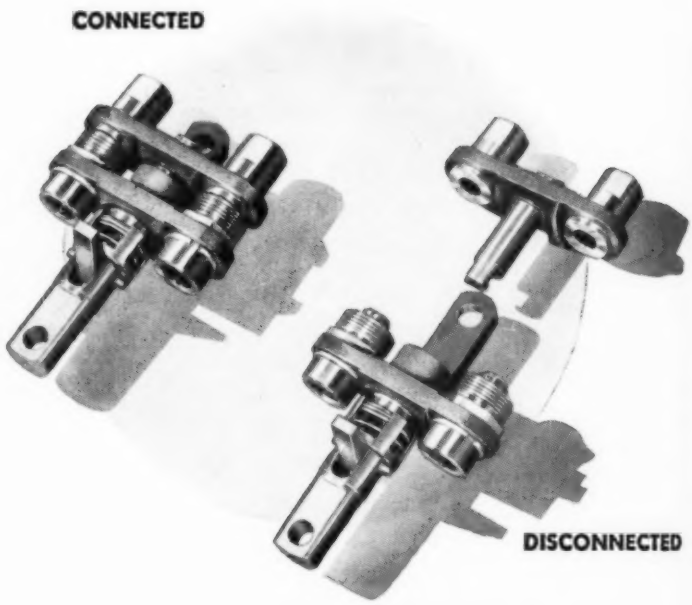

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PAUL L. REED
Editor

R. W. ELMENTHALER
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Production Department
WILLIAM V. LINAS
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Circulation Department
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Editorial and Business Office
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Cleveland 13, Ohio
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FRONT COVER: The guided missile, a veritable maze of hydraulic and electronic power and control equipment, is shown being elevated to its launching position, preparatory to fuel charging and loading with scientific equipment. Story on page 8.

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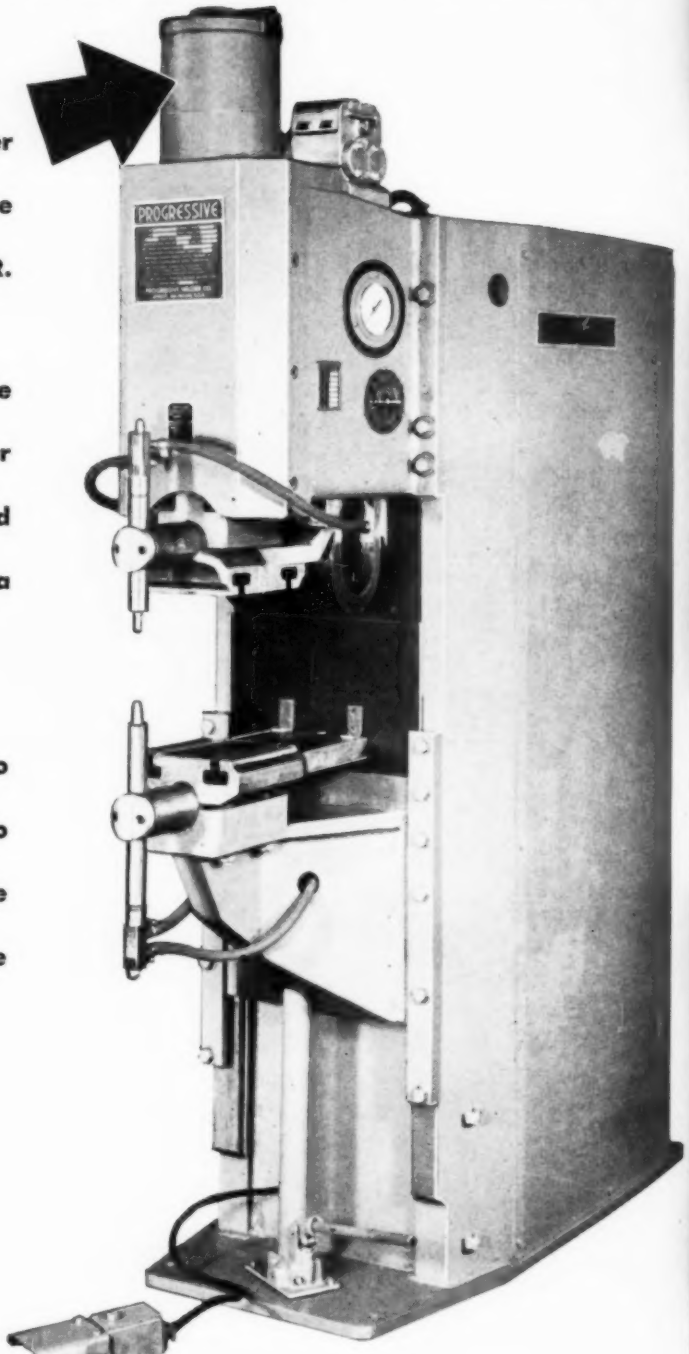

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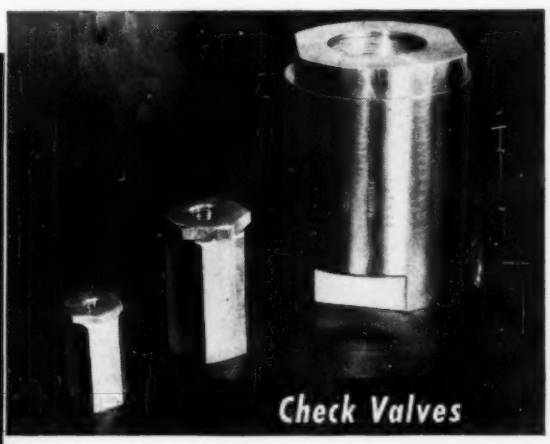

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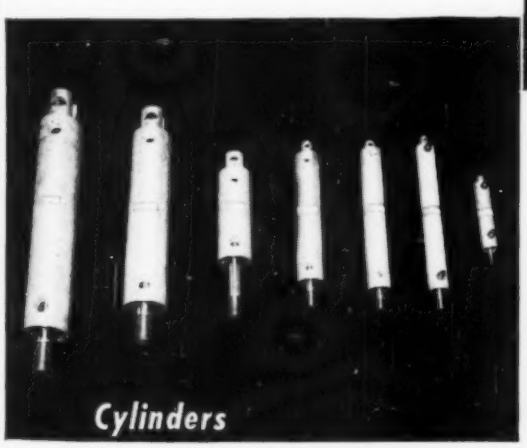

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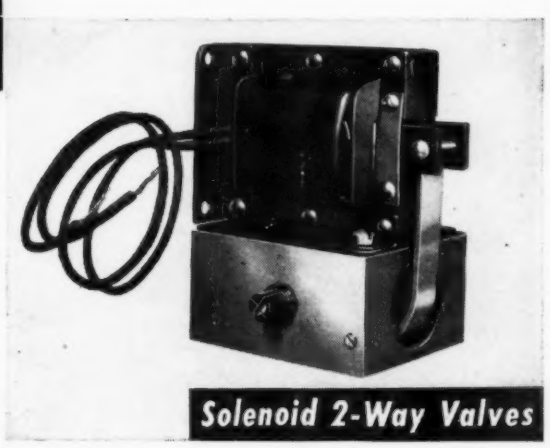

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HYDRAULICS and the GUIDED MISSILE

This discussion outlines the large part that hydraulic elements have played in the early American guided missile program. The tremendous technical difficulties are pointed out in terms of the German development which has been the starting point for American advances in this field. The increasingly important role of hydraulics in this program is accelerating technical advantages which will undoubtedly be advantageous to industrial applications.

By E. H. BULLER and B. H. FORD,* 1st Lt., U.S.A.F.

Fig. 1. The German V-2 type missile in an early stage of launching flight at White Sands, New Mexico.

THE RECOGNITION of the guided missile as a realistic military weapon has opened another field for the application of fluid flow principles. In commercial aircraft design, hydraulics has long been an established workhorse; its power operates landing flaps, landing gears, shock struts, brakes, propeller pitch controls, turret drives, autopilots, servos and similar assemblies. The new fields of supersonic aircraft and guided missile flight will, undoubtedly, put further demands upon the hydraulics industry to deliver hitherto unprecedented performances to satisfy new design and operating requirements.

For the purpose of clarification, a guided missile differs from the normal concept of conventional aircraft in that it is essentially a flying body stabilized in altitude, which can be guided through space, either by remote control or by means of self-contained guidance equipment, to a specified target. Another difference is that once a missile is fired or launched, it is, except through radio links, beyond manual operation or manipulation of integral equipment. Accordingly, if the mission is to succeed to any degree, equipment must function properly and dependably.

From the above considerations it is evident that design criteria imposed upon missile equipment will tax the designer's ingenuity and judgment. A further complication arises from the expendable nature of this equipment—the missile in part or whole is a one-shot affair. In this respect, the designer will also be asked to simplify design and production details to the highest practical degree and to achieve an optimum economy without sacrificing dependability of performance.

*Project Engineers at the Equipment Laboratory, Engineering Division, AMC, Wright-Patterson Air Force Base, Dayton, Ohio.

German Guided Missile Developments

The cessation of hostilities and subsequent removal of security barriers revealed the comparatively startling advances made by German scientists and designers in the missile field. A multitude of both subsonic and supersonic craft of varied types was either under development or developed for operational use; some of these missiles had reached a high degree of performance. Notable among the latter were the popularized V-1 and V-2 types. In some respects the V-2 typifies a successful craft, and is a standard research vehicle currently used both in this country and abroad.

All illustrations courtesy United States Air Force

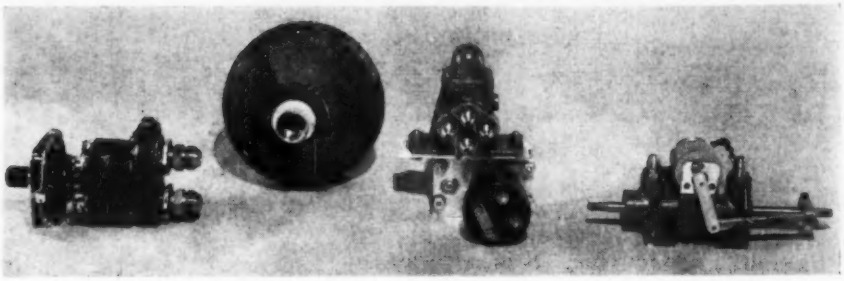


Fig. 2. Typical line-up of hydraulic components of a control system-pump, accumulator, control valve with electric input and servo with electric displacement follow-up.

The wartime V-2 was a ground-launched, self propelled bomb, 45 feet in height and carried a 2,000 pound warhead. A typical fuel load consisted of 7,000 pounds of alcohol and 11,000 pounds of liquid oxygen, bringing the total weight of the fueled missile to 28,000 pounds. Complete burning time was limited to approximately 60 seconds. After fuel cut-off, the missile became a free body and assumed the usual trajectory of a projectile. The maximum velocity, which occurred at the time of thrust cut-off, was approximately 3,800 miles per hour.

It is quite apparent that the fuel consumption and power required to drive pumping machinery are beyond normal expectations. Moreover, the fuel was fed into the burners by two pumps, both steam turbine driven. The steam was generated on demand by the decomposition of approximately 300 pounds of highly concentrated hydrogen peroxide. Products of this decomposition were superheated steam at 700 F and 700 psi and some free oxygen. The total weight of pumps and turbine was 220 pounds.

The control surfaces of the missile were operated by means of individual hydraulic servos. System pressure was developed by electrically-driven gear pumps totally submerged in the oil sump to prevent formation of air pockets and to reduce line length to an absolute minimum. The latter requirement was imposed by the installation of the pump and servo units directly into the tail fins. It should be remembered that space limitations in most missiles are almost always critical, regardless of the equipment concerned.

Applications of Hydraulics

Contemporary missile designs account for various applications of hydraulic equipment, basically to deliver fuel and to operate control surfaces. Liquids to be pumped might include oil, alcohol, liquid oxygen, hydrogen peroxide and various other fuels and oxidizers. Hydraulically operated servos might require system pressures ranging from a few hundred to beyond 5000 psi, whereas fuel delivery systems might be measured in terms of V-2 flow requirements. It seems reasonable to expect tailor-made equipment developments for prototype missile applications, but standardized systems and components are the necessary aim of the Services and missile producers. Ground handling and launching equipment for missiles also utilize hydraulic principles for their operation.

Control Systems

Hydraulically operated servomechanisms have been a highly respected standard in industry for many years. The principle has also been applied with repeated success to the design of aircraft and missile autopilots, or control systems, as they are referred to in the missile vernacular. The control system is of special interest inasmuch as hydraulics is competing with electrical, mechanical and pneumatic systems in the field of missile control equipment. Allowances in performance of such systems are progressively being diminished to finite values. Time constants are now being expressed in terms of hundredths and thousandths of a second, which does not allow much margin for error. Serious competition between the various methods of operation for the greatest

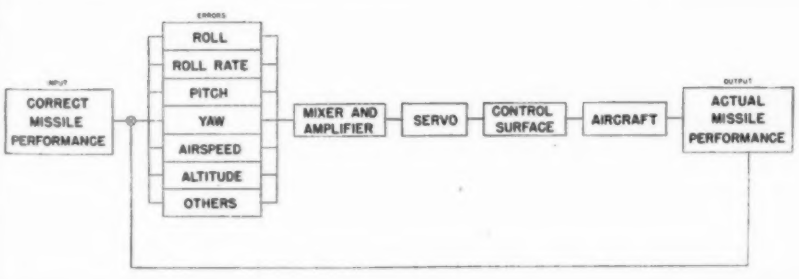


Fig. 3. Schematic diagram of a guided missile control system.

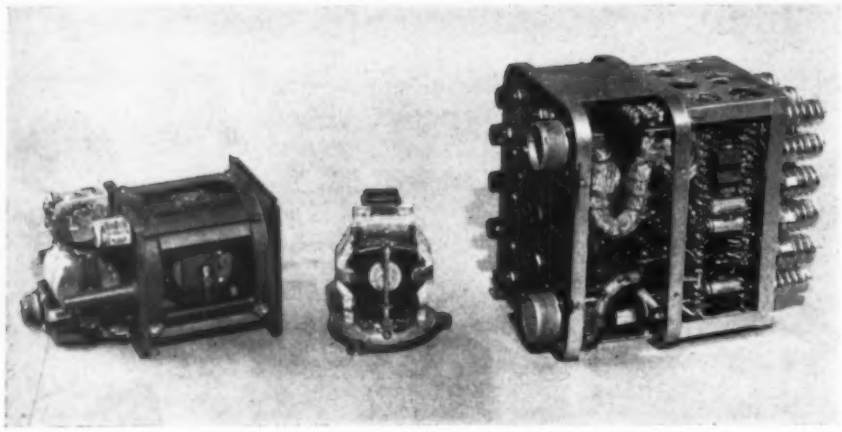


Fig. 4. Examples of other control system components—angular displacement and rate detectors and electronic amplifier. The amplifier design shows the demand for compact construction and versatility.

measure of performance has begun.

In an attempt to give a rounded picture of the problem confronting the designer of such control systems, the following paragraphs are devoted to a concise discussion of the elementary theory and evaluation factors of a guided missile system.

The control system of a guided missile is synthesized as a closed loop system, i.e., if an error occurs in the missile's position, velocity, acceleration, air speed, ground speed, altitude or any other parameter of its flight, this error is detected and measured by some type of indicator which in turn actuates the servomechanism and subsequently attempts to reduce the error to zero. Such a closed loop system is schematically illustrated in Figure 2.

To better understand the many and varied aspects involved in controlling a guided missile or pilotless aircraft in general, visualize the problem of designing a control system for some guided missile in particular. First, the exact actions desired of the craft must be determined. Specifications regarding the mission of the missile are decreed by tactical purposes, but the designer must have a thorough understanding of the mission to create an ultimate performance toward the achievement of each type of mission. Sometimes the task of the control system designer is difficult and the work of the propulsion engineer is compartively easy; again, the opposite is true. The craft may be designed to be especially adaptable to any of the following missions:

(1) Launch from ground and pursue long-range course to a selected type target on the ground

(2) Launch from the ground and pursue a collision course to a target in the air

(3) Launch from the air and pursue a collision course to a target in the air

(4) Launch from the air and pursue a short-range course to a selected type target on the ground

(5) Launch from the ground and pursue a short-range course to a target on the ground, or

(6) Launch from the ground and respond to radio control.

Depending upon the immediate purpose of the craft, any of the following maneuvers or combinations of maneuvers may be desired:

(1) Straight and level flight

(2) Straight and level flight at a given altitude

(3) Straight and level flight at a desired altitude and airspeed

(4) Take-off, followed by straight and level flight

(5) Take-off, straight and level flight, coordinated banks and turns

(6) Take-off, flight on a predetermined course, descent by parachute

(7) Take - off, subsequent flight by radio beam

(8) After release from another aircraft, follow a collision course to a designated object, or

(9) Take-off, respond to the controls of an operator on the ground.

To create a control system that will accomplish any combination of the above type of maneuvers involves a complicated array of controls. Presume that the missile has just been released by an aircraft and is in the atmosphere traveling at the desired speed, headed in the desired direction, possessing power to maintain selected airspeed and experiencing no immediate disturbance. Should an error occur in the direction, for example, because of a gust of wind or another factor, there are two methods of giving a missile a push to the desired direction:

(1) Moving an aerodynamic control surface and creating a force or torque by means of the air through which the vehicle is moving, or

(2) Activating a lateral jet, an explosion or a similar inertial reactor.

Should the missile be designed to fly through the stratosphere, where the air becomes progressively thinner, the latter type of control is a necessity. Otherwise, because of the fuel involved and other practical considerations, the aerodynamic control surface affords the easiest solution. If aerodynamic means of control are chosen, there are several methods by which the control surface may be moved relative to the error. One method provides movement of the surface at a constant velocity above a certain level.

Systems of this nature are often referred to as "bang-bang" control. In some instances the control surfaces are self-streamlining after the error reaches a zero position; such a condition removes the necessity of the servo motor cranking the surface to a neutral position after the missile has responded to the control. Another method, known as a "proportional torque" system, applies a torque to the control surface proportional to the error that exists. As in the previous case, the surfaces are usually self-streamlining. In this method there is the advantage of having the desirable tendency to provide for constant reaction of the missile to the control surface. For instance, when the vehicle reaches atmospheres where the effect of the control surface is reduced, the same torque will move the control surface farther out into the airstream and thus tend to maintain the same amount of control. Yet another type of system has provisions for moving the control surface angularly into the airstream at an angle proportional to the error. This is known as a "proportional control" system.

Proportional Control System

There are other types of systems, but for this discussion assume that proportional control would be used for the stabilization of a missile. A simple pendulum illustrates a proportional control system. By definition, a servomechanism must be characterized by an amplification of power. A pendulum does not have this characteristic, but it nevertheless has the same dynamic performance. To further illustrate this condition it should be remembered that an aerodynamic control surface will create a torque which is nearly proportional to the angle at which the surface is extended into the airstream, particularly for the small angles over which a control surface normally operates. It follows, then, that a proportional control system will provide a restoring torque to any axis of a missile which is proportional to the angular error that exists about the axis. Similarly, a pendulum has a restoring force relative to the vertical position that is proportional to the angular error from the vertical position. Should a pendulum be given an unbalancing disturbance, it would tend to oscillate. A missile with this type of control given an unbalancing disturbance would also tend to oscillate. This is an undesirable characteristic and steps must be taken to eliminate such a reaction. The oscillations in a pendulum can be damped out by placing the pendulum in a fluid more viscous than air. Damping is defined as an opposing force or torque which is proportional to the velocity of an object.

In a missile there are two general methods by which the oscillations can be damped out:

(1) Aerodynamic damping, which is a result of the air tending to prohibit rotation about any axis, or

(2) Prediction circuit damping.

In the first method the aerodynamic damping on the missile is a fixed quantity that cannot be governed by the control system designer. Because of the small wings or fins of the typical missile, the worth of this type of damping is usually small but it has some value. Prediction circuits measure the rate of roll of the missile about any axis and reduce the proportional control by an amount relative to the rate of rotation about that axis. Reducing the proportional control has the same effect as adding an opposing torque, which is relative to the rate of rotation and thus damps out oscillations. Prediction circuits can easily provide excessive damping to the extent of causing immovability in a missile. This condition is similar to a pendulum trying to oscillate in an atmosphere of mud. To reduce an error quickly to zero and prevent overshooting and cause oscillations, it is better to provide critical damping or slightly less.

Control System Considerations

It is obvious that a control system is not basically complicated, but there are several factors which may greatly upset the simple equations that would otherwise apply for such a system. To list a few:

(Continued on page 28)

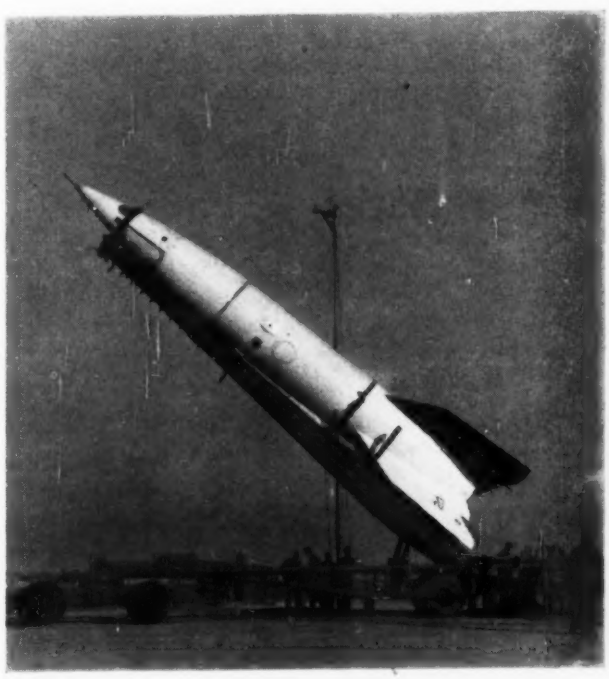


Fig. 5. A V-2 missile being raised to its vertical launching position by a twin cylinder hydraulic lift.

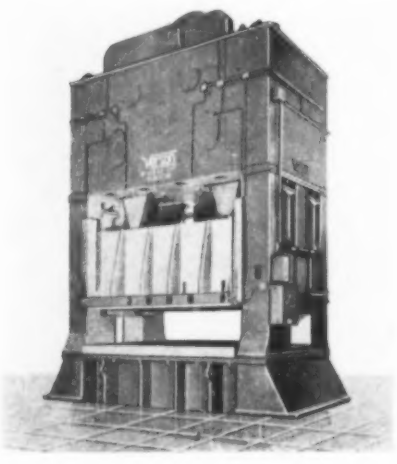
WHAT TYPE OF PRESS should you buy?

This discussion is divided into two parts—the first covers the classifications of metal working most advantageously done on hydraulic and mechanical presses—the second part is a check list of advantages and disadvantages of hydraulic single and double action presses and of mechanical single and double action presses.

By H. L. REYNOLDS
Manager, Hydraulic Division
Verson Allsteel Press Co.
Chicago, Ill.

BUYING a press is no different from buying any other equipment. The operational characteristics of a press design are considered in relation to the requirements of definite classes of work to be done. Obviously, there are operations that are best suited to mechanically operated presses and others that are most efficiently done on hydraulic presses. And, like in any such division, there is a third group of operations that might be done on either type of press. Our discussion will consider three such groups or classifications of operations; after which a list of advantages and disadvantages of the two types of presses will be made.

Fig. 1. A typical single action 400 ton capacity mechanical press.



The selection of a press for the production of a particular piece part should fall in one of the three classifications:

(1) a piece part which is best or most economically produced on a mechanical press

(2) a piece part which is most suited for a hydraulic press, and

(3) a piece part which can be made on either a mechanical or hydraulic press. The choice is dependent on factors later referred to, and often upon individual preference or on the ability of the salesman representing the type finally chosen.

Because of the controversial nature of the third classification no recommendation of parts to this category will be made. Instead, an effort will be made to point out the factors which should influence the selection of a press.

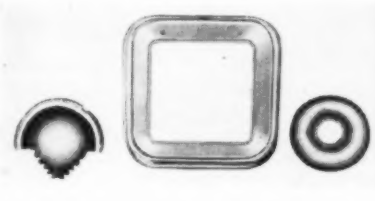
Classification 1—Mechanical

Whenever possible, blanking operations should be done on a mechanical press. A hydraulic press should be used only when a mechanical press is not available. The break through shock is very destructive to a hydraulic press and more attention to protective maintenance is required.

Maximum rake on dies and positive stops at break through should be incorporated. When the outer or female part of the blank is to be used, caution should be exercised on the amount of rake, since excessive rake causes stock curling.

Trimming is primarily blank-

Fig. 2. Drawn parts made on a mechanical type press.



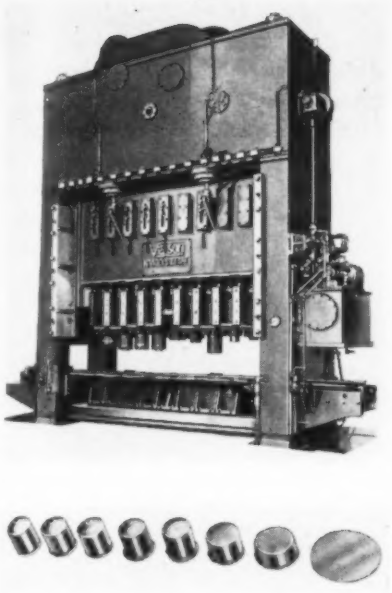


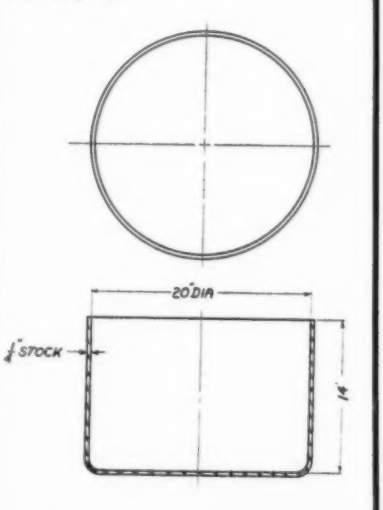
Fig. 3. An eccentric type mechanical transfer press and the stages of an oil cleaner body produced on it. The cover body is completed from coil stock to finished piece in 8 progressive operations.

ing after the piece is formed or drawn, and the above suggestions apply.

Piercing is in the same classification as blanking and trimming.

Forming of not more than 3 or 4 in of depth is essentially a mechanical press operation. Air forming is more accurate on the mechanical press than on a hydraulic, as the depth of form is regulated by the throw of the crank.

Fig. 4. Plan and elevation views of a shell, typical of work done on a hydraulic press.



Our author, H. L. Reynolds, has spent the greater part of his years in the press field in the employ of companies making both hydraulic and mechanical presses. He has designed, sold and shot trouble on both types of presses. Every effort has been made to present unbiased facts on the merits of the two types of presses.

Draws of shallow and medium depth are generally suited to a mechanical press. The depth of draw economically produced on a mechanical press varies with the production or length of run. It is generally agreed that draws up to 3 or 4 in deep are best suited for mechanical presses, regardless of the production run. A simple mechanical press of 400 ton capacity is shown in Figure 1. Drawn parts formed in this type of press are shown in Figure 2.

Coining or sizing operations in open type dies are usually best suited to mechanical presses, particularly of the knuckle joint type.

Forging, in general, is produced on mechanical presses. This has been due to the fact that mechanical presses do not dwell at the bottom of the stroke, thus washing out dies. Some recent hydraulics have minimum dwell. However, operating data is insufficient to judge their adaptability to forging.

On high production runs, over 8,000 to 10,000 pieces per week, every effort should be made to use a mechanical press. There is, incidentally, a tremendous ratio of mechanical to hydraulic presses in the automotive, coaster wagon and other very high production industries.

Where production exceeds 20,000 to 25,000 pieces per week, consideration should be given to mechanical transfer presses. Figure 3 shows a 9 station press for producing an oil cleaner body. This cover is completed from coil stock to finished piece in 8 progressive operations on one press with one operator at the rate of 840 pieces per hour.

Where roll feeds or progressive dies are used for feeding coil or strip stock, mechanical

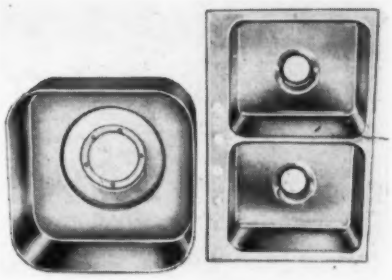


Fig. 5. Deep drawing operations to form shells like these are ideal for a hydraulic press.

presses should be used. The mechanical press with its positive timing is ideal for the adaptation of these feeds.

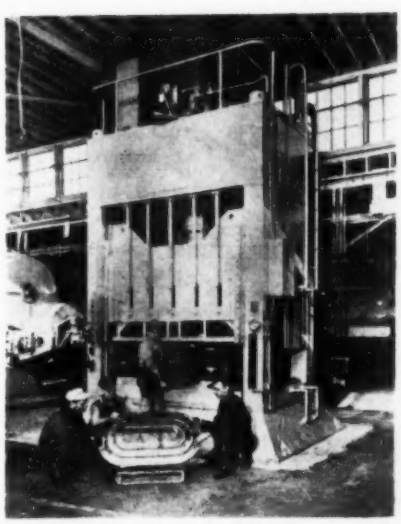
While dial feeds are easily adaptable to mechanical presses, there have been some successful installations of dial feeds on hydraulic presses.

Classification 2—Hydraulic

It is well known that hydraulic presses are superior to and more economical than mechanical presses on deep draws. Figure 4 illustrates a shell, a typical hydraulic job. Figure 5 pictures other deep draws which are ideal for a hydraulic press. Figure 6 shows a conventional single action hydraulic press of 500 tons capacity.

To explain the problem of press selection on this item (Figure 4), let us try to produce this piece on a mechanical press.

Fig. 6. A conventional single action hydraulic press of 500 tons capacity.



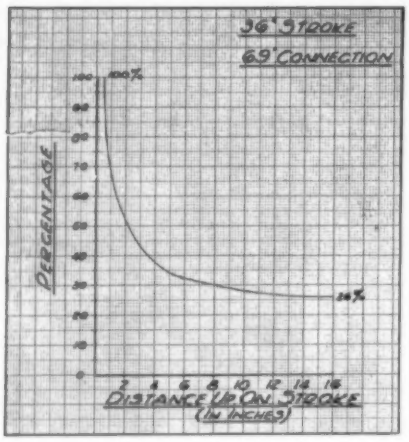


Fig. 7. Tonnage factors on a 36 in stroke mechanical press.

The piece is of deep drawing stock (55,000 pounds tensile). The tonnage to pull the bottom out of the piece will be used as the maximum tonnage required without overcoming cushion.

Tonnage without cushion:
20 in $\times$ 3.1416 $\times$ .25 stock
$\times$ 27.5 tons = 432 tons
Tonnage of cushion:
120 tons

The above tonnage of the cushion was obtained by experiment on this type of shell.

As a safety factor we shall use a 650 ton hydraulic press with a 150 ton cushion capacity as the base press. The press is to have a 36 in stroke.

It must be remembered that mechanical presses are generally rated one-half inch above the bottom of the stroke. From the chart, Figure 7, which graphically represents various tonnage factors on a 36 in stroke mechanical press, we divide the 650 tons required at 14 in above the bottom of stroke by the stroke factor of .26. From the chart, a mechanical press of comparable power at the point of stroke where the draw is started will have 2500 tons on the main slide and still have 200 tons cushion capacity:

$$650 \div .26 = 2500 \text{ tons.}$$

This draw requires 9,100 inch-tons in the flywheel, which means that were we to use a 250 hp motor and a flywheel of 80 in outside diameter, the flywheel would weigh 21 tons and the press as a whole would be tremendously large in comparison with the 650 ton hydraulic.

From this, it is apparent why hydraulic presses are habitually used on deep drawing parts.

Parts of a contour which require unusual movement and slow movement of the metal being drawn, can be produced to much better advantage on a hydraulic press. The wringer shroud shown in Figure 8 is being produced in one draw on a 200 ton hydraulic press with a 100 ton cushion in the bed and a 30 ton cushion in the slide. This piece, which is 42 inches long after stretching, is drawn from a blank 32 in long. The unusual contour of the piece is shown in Figure 9.

Straightening, both in open and closed type dies, is a purely hydraulic press operation. In open or bar straightening, the hydraulic press may be advanced the proper amount and at the precise speed for exact straightening. The direction of movement of the ram is immediately reversible.

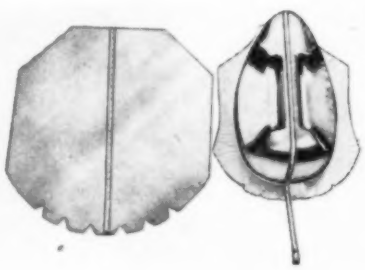
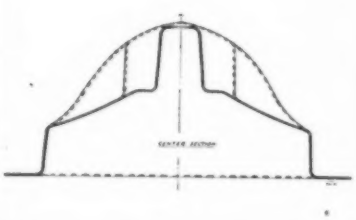


Fig. 8. The blank and finished wringer shroud deep drawn in one operation on a 200 ton hydraulic press.

In closed die straightening the hydraulic press will build to a certain tonnage and no more. Regardless of thickness or irregular contour of the piece, the press cannot be overloaded. Mechanical presses should never be used on the operation.

Fig. 9. The contour of the wringer shroud.



Hydraulic presses have been successfully used in operations where large areas of inaccurate thicknesses of metals are encountered and in hot forming, where the metal is not brought to a heat that will wash out dies.

Hobbing, which is sometimes classed as a metal working process, is an ideal operation for hydraulic presses and should not be tried on a mechanical press.

Die try-out presses are usually hydraulic. Otherwise, as on the deep draws, a much heavier mechanical press would be required. The operator can spot his dies, make the try-out, going to any depth; then make an immediate reversal for observation. The time of die setting in the press is less, since no adjustment for stock thickness is necessary.

Classification 3—Optional

In this class are the many parts which can be produced either by mechanical or hydraulic presses. The choice is usually made by the individuals purchasing and using the presses. Rather than attempt to recommend either type on these border line cases, we will try to present information that may be useful in making a selection.

The author recently prepared a paper for a large corporation to assist their personnel in the selection of presses. A condensed version of this paper follows. Essentially, this paper contained a list of advantages and disadvantages of the two types of presses in both single and double action.

Hydraulic Single Action Press Advantages

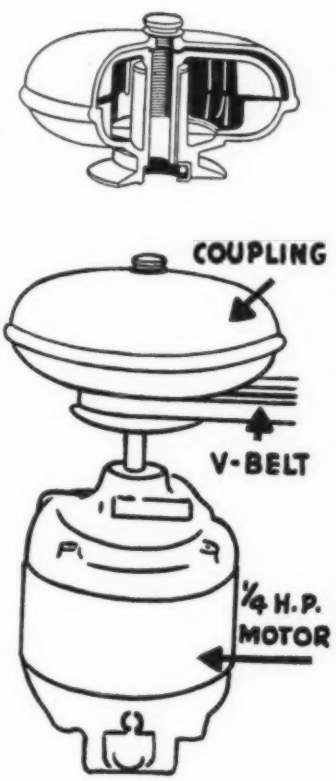
(a) Cannot be overloaded as the system is protected with two separately adjusted relief valves.

(b) Full tonnage is developed through the entire stroke. In mechanical presses a reduction factor is used on the tonnage,

(Continued on page 18)

FLUID POWER for Spin Drying

A first use of a fluid coupling to drive a spin tub assembly in an automatic washing machine.



Top — Cutaway drawing of coupling, showing adaptor, impeller and runner; bottom— relation of coupling to vertically mounted motor.

The automatic washing machine manufactured for Associated Merchandising Corporation by Beam Manufacturing Company, Webster City, Iowa, incorporates a fluid drive for the spin drying part of the automatic cycle. As far as known, this is the first use of a hydraulic coupling for the operation of a domestic washing machine. Slippage in the coupling prevents overloading, which can be damaging to the electric motor drive unit, eliminates the dangers of off-center loads and provides a smooth, cushioned, flexible flow of power which means longer wear and fewer breakdowns.

A standard fluid coupling is used, mounted horizontally over a ¼ hp electric motor. The coupling is connected to the bottom shaft of the spinner tub by a V-belt and is cut-in automatically through a relay when the spin drying begins. The complete cycle is automatic and is regulated by a knob controlled switch on top of the machine.

The interior member or impeller of the coupling is attached to the motor drive shaft by means of a special adaptor. Two stamped vanes, riveted to the underside of the impeller, extend down into the fluid in the lower housing. The housing is a two piece cast aluminum alloy casting welded together to make a joint absolutely tight against any leakage. Internal pressure builds up if the coupling is subjected to prolonged operation with excessive slippage and it is difficult to get a tight joint by bolting the parts together or by threading them.

The lower half of the housing has a series of straight radial fins and acts as the runner element of the coupling. Mounted horizontally, the impeller is on top, the lower housing or runner, with the pulley channel, is on the bottom of the unit. As the motor drives the impeller shaft, the straight vanes create a turbulence in the oil in the lower housing. The pressure of the rotating fluid causes the runner to turn. Normally, the full speed of 650 rpm is quickly attained.

In the event that the spin tub load is eccentric or becomes eccentric in excess, slippage will prevent the spin tub assembly from reaching the maximum speed. Eccentricity naturally lessens as the water is spun out of the materials being washed and the fluid drive will permit the spinner tub to increase speed until it reaches full motor speed.

Fig. 1. The pump, pilot operated valves and operating cylinder for the drive of the boiler grate.

OIL COOLING INCREASES PUMP EFFICIENCY

THE IMPORTANCE of cool oil in a hydraulic system is well understood by experienced operators. The overheating of hydraulic oil is probably the cause of more troubles, directly and indirectly, than any other operating factor in hydraulic systems. Oil that operates at temperatures appreciably above the range for which a system is designed accelerates the breakdown of the oil and the formation of harmful sludges and varnishes. Hot oil increases internal leakage and reduces both the efficiency and the overall capacity of pumps. However, the best planning and designing cannot always anticipate changes in operating conditions.

Recently a Pennsylvania power plant converted over to strip-mined coal. The boiler in the plant was equipped with an American Engineering Company "Perfect Spread Stoker", the grate of which was hydraulically operated to remove the ash. The immediate problem was the ash content of the strip-mined coal which ran as high as 30 per cent. As this was far in excess of the normal ash content, the speed of the grate had to be increased proportionately to remove the accumulated ash.

The existing pump operating the hydraulic system had a discharge capacity of 0.9 gpm of oil at 800 psi. This capacity was calculated from the speed of the grate and the size of the hydraulic cylinder. The oil in the system had a viscosity of 600 SSU at 100 F. Due to radiation from the ash pit and the firebox, the oil temperature in the system was constant at 127 F. The 0.9 gpm was insufficient to handle the ash removal; so that the problem was either to install a larger pump or to increase the capacity of the existing pump.

The problem was quickly and very inexpensively solved by the installation of a single-pass design heat exchanger of shell and tube type. Water is used as the heat exchanger medium. The oil is cooled rapidly by passing over baffled external tube surfaces. The exchanger cooled the oil down to 95 F within 30 minutes after the water was turned on.

At this temperature the speed of the grate was just double that at which it formerly operated. On this basis the calculated pump capacity had been increased to 1.8 gpm.

With other oil conditions under control, it is axiomatic that cool oil is a safeguard to efficient, maximum capacity operation of a hydraulic system. While it is obvious that the doubling of a pump's capacity cannot be expected on larger installations, this installation dramatically illustrates the value of an oil cooler for cutting down internal pump leakage and prolonging oil life expectancy.

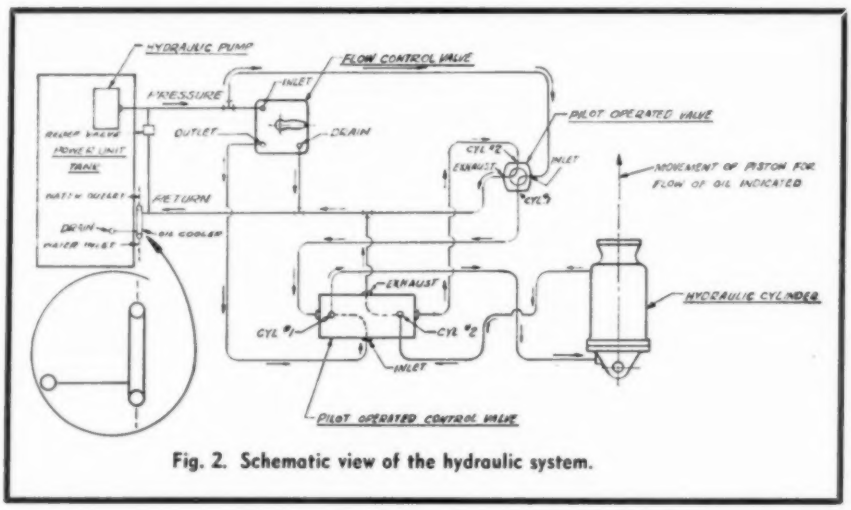


Fig. 2. Schematic view of the hydraulic system.

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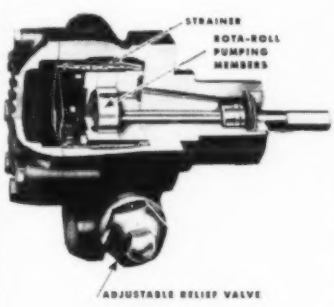
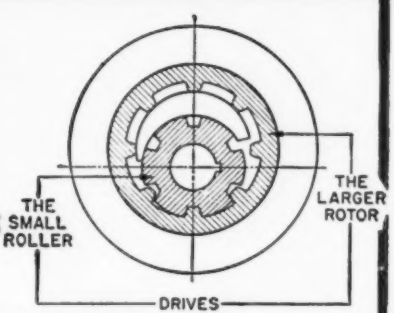


Small, Compact and Quiet in Operation

You'll like the quiet performance of this pump, and you'll like the ease with which it can be adapted to your design. It's small, compact, and will improve the appearance of your product.

Rota-Roll Principle Offers 6 Advantages



1. ROTA-ROLL PRINCIPLE of pumping members promotes quiet operation, longer life because (see above) smaller roller is keyed to shaft and drives outer member at a speed 25% lower than motor speed.
2. QUIET OPERATION because ROTA-ROLL pumping members and efficient inlet port design reduces cavitation at the inlet port.
3. SMOOTH UNIFORM FLOW AT ALL PRESSURES because rotating roller and rotor are self-emptying, eliminating turbulence, and other interference with smooth uniform flow of oil.
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WHAT TYPE OF PRESS?

(Continued from page 14)

depending on the point above midstroke where work is encountered.

(c) Maximum press tonnage is readily adjustable. A 200 ton press may be set to operate at a maximum of 50, 55 or 100 tons or any other. Fragile dies are protected in this way.

(d) The stroke is adjustable for the work being done. For example, a 30 in stroke press can be set to operate at 3 or 4 in on a shallow form.

(e) Die setting is accomplished in less time than required on mechanical presses since it is not necessary to adjust for material thickness or variation of stock.

(f) Presses slow down before entering the work, then draw at a constant speed throughout the entire draw. There are no problems of midstroke velocity or tearing due to impact.

(g) The press is self-lubricating except gibs and cushion guides.

(h) The press may be reversed either on pressure or distance. In other words, the press may be reversed by closing the dies and building up the preset pressure or on depth of draw in an open die.

(i) In general, the single action hydraulic press with cushions has the lowest first cost on presses of long strokes.

Disadvantages

(a) The single action hydraulic press from the standpoint of housekeeping (oil leakage) is inferior to the mechanical presses. While great strides have been made by some manufacturers in eliminating oil leakage, there is still leakage on hydraulic presses.

(b) This press does not have individual adjustment at the four corners of the blankholder plate (as do double action hydraulic or mechanical presses) which is actuated by the cushion. To obtain variable pressures at corners, it is necessary to shim the pins or use other means.

(c) A much larger motor is required, as compared with the mechanical single and double action, as no energy is stored in the flywheel. However, the hydraulic press does not require more electrical current than the mechanical press as the motor operates at approximately full load only through the time of the pressing period.

(d) Not applicable to blanking operations since the shock of break through is detrimental to piping, gaskets and press connections.

(e) More difficult to maintain than mechanical presses. This is true chiefly because breakdowns of mechanical presses are of the visual type and easily detected. To trace a hydraulic breakdown usually requires a thorough understanding of the circuit, as the source of trouble is seldom visual.

(f) Nested or multiple die set ups are not advisable unless pressures are reasonably well balanced. This is seldom possible.

Hydraulic Double Action Press

Advantages

(a) The hydraulic double action press has four corner blankholder adjustment at finger tips. The tonnage set on each corner can readily be seen on the gauge above the control.

(b) It cannot be overloaded as it is protected on either the blankholder or the punchholder with dual relief valves.

(c) Full tonnage is available on both punchholder and blankholder throughout the stroke.

(d) This press is equipped with a tonnage regulator on the punchholder as well as on the blankholders. Any required tonnage may be set as a maximum on the punchholder.

(e) Any length of the stroke of the punchholder or blankholder may be used. Top of stroke, bottom of stroke and slow down limit switches are all adjustable.

(f) Die setting requires less time than on a mechanical double action press since it is not necessary to adjust for material thickness or variation in stock.

(g) The press slows down before the blankholder contacts the work, advances at pressing speed to the work, and then draws at a constant speed. In contrast, the mechanical press on deep draws has its highest slide velocity at the moment it contacts the work.

(h) The hydraulic double action press is automatically lubricated except for the punchholder gibs, blankholder gibs and cushion guides.

Disadvantages

(a) The hydraulic double action press must, of necessity, have a large number of valves and pipe lines.

(b) A large motor is required as energy cannot be stored in the flywheel.

(c) The initial cost is high compared to hydraulic and mechanical single action presses with cushions.

(d) The hydraulic double action press is by far the most difficult of all types of presses to maintain. This is due to the relatively complicated circuit with the large number of valves and pipe lines.

Mechanical Single Action Press

Advantages

(a) The mechanical single action press with cushion is faster than hydraulic presses unless unusually large power units are applied to the latter.

(b) The same time is required for the downstroke and the upstroke. Hydraulic presses advance rapidly, take considerable time

(Continued on page 24)

LETTERS to the Editor

We are interested in obtaining some information on hydraulic forming wherein the metal sheet is clamped between two die members and the fluid is pumped to one side of the sheet at sufficient pressure to form it into the female die contour.

J.M.G.

The name of a company doing hydraulic forming in your vicinity is being sent to you.

The circuit drawings you publish vary in style and detail. It would be helpful if your circuit diagrams would be consistent, especially when they are preserved for reference.

P.T.

Drawings vary in symbols and details because practices differ in sections of the country, in industrial areas and within the same industry. It is expected that the General Motors Joint Industry Conference on Hydraulic Standards for Industrial Equipment will be a step in the direction of unifying and clarifying symbols and nomenclature for hydraulic circuit diagrams. The goal—a code as complete as that now universal in the electrical industry—will take time, but definite progress is being made.

The series of articles on air circuit designs by W. J. Schupner are very good. Let us have more of them.

J.M.

We are glad that you like Mr. Schupner's work. His articles will continue to appear in alternate issues.

Just finished reading the August issue of APPLIED HYDRAULICS and think it excellent. Would you please quote me on the entire group of back numbers since I find this material a very desirable addition to my hydraulics library?

S.J.K.

Because of the carefully controlled method of distribution of this magazine, back numbers are scarce. We are sending copies that are available with our compliments.

Have the papers delivered at the National Conference on Industrial Hydraulics last year been published?

J.P.

The proceedings of the 1947 National Conference on Industrial Hydraulics have been published in permanent form. Included are ten complete papers, a program of the conference, officers and committees and a list of registrations. Copies may be obtained at $3.00 each from Armour Research Foundation, Technology Center, Chicago 16, Ill.

This column is open to comments on general trade and technical problems. Comments are invited from our readers on questions or answers as published—EDITOR.

What's Your machine design problem mister?

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OIL HYDRAULICS . . .
The Modern Power Application

By WILLIAM J. SOLOMON
Hydraulic Engineer
Aetna-Standard Engineering Co.
Youngstown, Ohio

OIL HYDRAULICS is the modern power application. Because we attempt to utilize present day equipment for modern operation by the standards of yesterday, the results are often short of what we may expect. Oil hydraulics has had difficulties characteristic of a new type of power application. At times the results may be so uncertain that we are inclined not only to ignore the definite advantages of oil hydraulics for the many power applications under our direction, but also to become prejudiced against the introduction of oil hydraulics to applications where their superiority is patent.

To illustrate, let us take an application in which a carriage, upon which is mounted a tilting hopper or cradle, is to be traversed between two stations (A and B) by a cylinder (T1) and the hopper or cradle is to be tilted by a second cylinder (T2) at station B. A third cylinder (T3), which functions independently of cylinders T1 and T2, is to be operated by the same hydraulic system.

The Simplest Arrangement

The simplest arrangement for performing the above functions is shown in system A1, Figure 1. A motor drives a 30 gpm constant volume pump P1, which supplies the pressure to operate cylinders T1, T2 and T3. The cylinders are controlled by operating valves V1, V2 and V3. The entire system is protected by relief valve R1.

This system will operate satisfactorily and fulfill its expected performance, but it will have the following disadvantages:

(1) The motor will operate at its full rating and maximum power consumption when the system is idling. The reason is that the horsepower should correspond to the power required to drive the pump at the relief valve setting pressure.

(2) To eliminate the power loss when the system is idling, the motors may be started each time the cylinders are required to operate. However, this means the motor must attain its full load speed under full load operation, with a burdening of the motor control and disturbances in the electrical supply system. A further disadvantage is the probable loss of operational time in starting and stopping the motor.

(3) Since the constant volume pump delivers oil at or near the rated capacity at all times when driven at its rated speed, oil will return through the relief valve to the reservoir when the system is idling. The resistance to this oil flow, created by the relief valve, causes the oil to gain heat.

(4) There is no synchronization in the operating of cylinder T2. It can be operated at will to tilt the hopper or cradle in any position of the carriage and while the carriage is in motion.

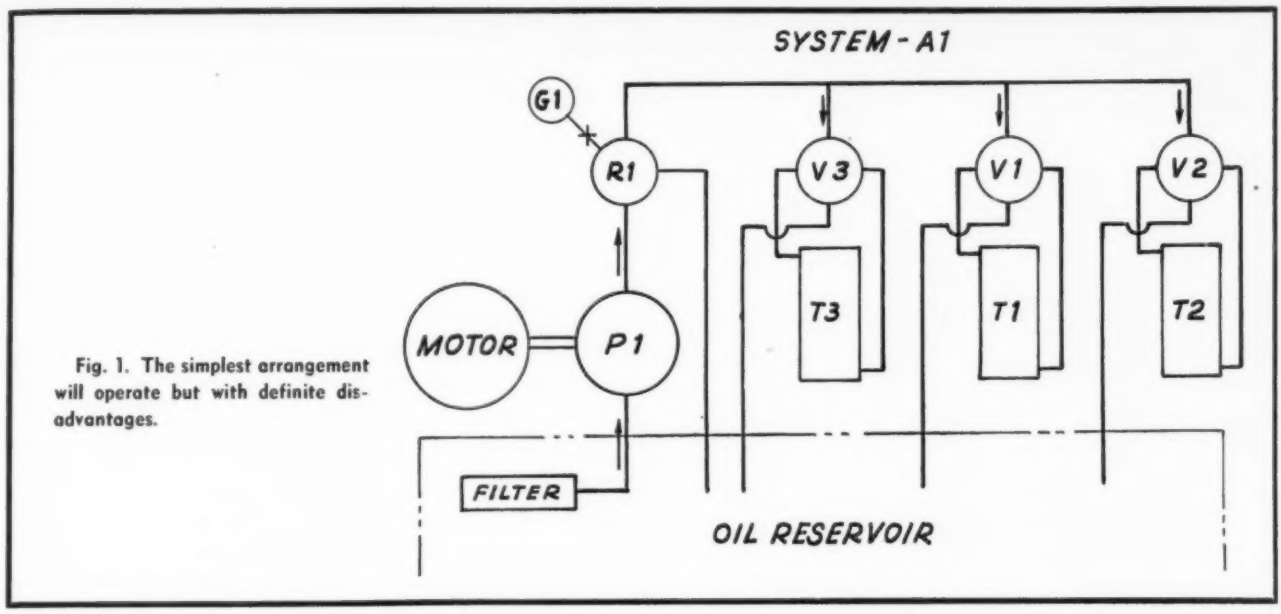

Fig. 1. The simplest arrangement will operate but with definite disadvantages.

P1—Rotary vane type constant delivery pump — capacity as required
P2—Rotary vane type constant delivery pump—one to two gpm
R1—Relief valve
K1—Unloading valve
S1—Sequence valve
C1—Check valve
C2—Check valve, modified, with 50 pound spring
T1, T2, T3—Cylinders
V1, V2, V3—Four-way, lever operated valves, closed center, detents
V4, V5—Four-way valves, solenoid controlled, pilot operated, spring centered. Closed center, modified, for cylinder ports to be open to tank when in center
F1, F2, F3, F4—Pressure switch
Y1, Y2, Y3, Y4—Contactor with interlock
B1—Electric switch, ON-OFF
B2—Momentary contact push button
G1, G2, G3—Pressure gage

Key to Figures 1, 2 and 3

A Second Arrangement

To eliminate the disadvantages of system A1, we evolve system A2, Figure 2. Pump P2, of approximately one gpm capacity, has been added to supply the control pressure for unloading valve K1. This enables the 30 gpm pump P1 to unload at minimum resistance when the system is idling, considerably reducing the power consumption of the motor so that the system can be idled economically throughout the working cycle. This arrangement eliminates the disadvantages 1, 2 and 3 inherent in system A1.

Pump P2 may be a separate unit or it may be incorporated with pump P1 into a double pump unit. Sequence valve S1 is added, achieving automatic control of the oil flow to the extent that the tilting cylinder T2 cannot operate while the carriage is in motion. This considerably reduces the fourth disadvantage of system A1.

System A3, which is fully diagrammed and explained, is shown in Figure 3. This arrangement offers the most efficient and positive method for performing the required functions. Here, by momentarily

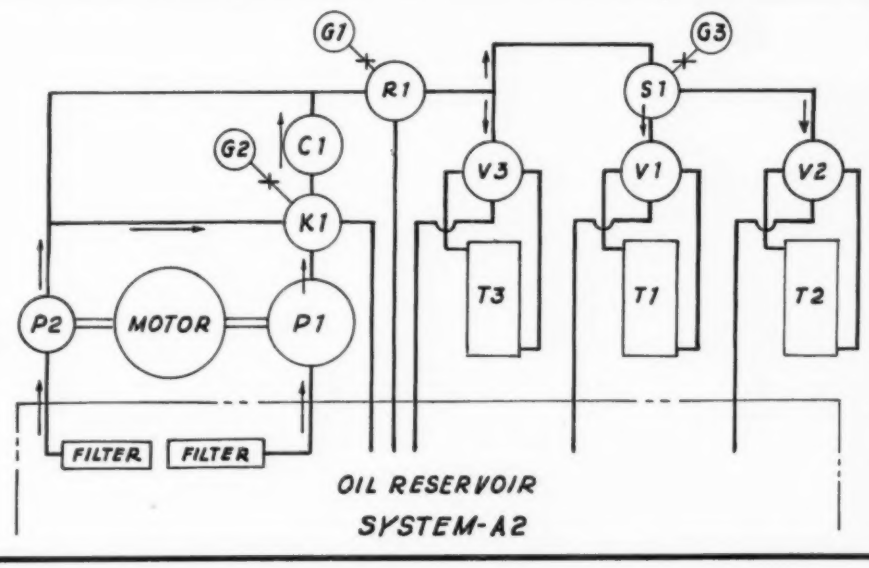

Fig. 2. A second arrangement improves control and reduces operating cost.

depressing a push button, we initiate the following automatic operation: the carriage is moved from station A to station B; held in that position while the hopper or cradle is tilted and retracted; after which the carriage is returned to station A.

A Third More Complete Arrangement

With switch B1 in the ON position, depressing push button B2 initiates the actions described below, causing the carriage to travel from station A to station B, the hopper to tilt and retract and the carriage to return to station A.

Contactor Y2 is energized, thereby energizing solenoid X4, operating valve V4 to admit oil at the blank end of cylinder T1, causing carriage to travel from station A to station B. At the end of this action the piston is dead-ended and the built-up pressure operates pressure switch F1 which de-energizes contactor Y2 and energizes contactor Y1.

De-energizing contactor Y2 also de-energizes solenoid X4, allowing valve V4 to center or to attain a neutral position. Energizing contactor Y1 causes solenoid X5 to become energized, thereby operating valve V5 to admit oil at the blank end of cylinder T2, causing hopper to tilt. At the end of this action, the built-up pressure operates pressure switch F3 which de-energizes contactor Y1 and solenoid X5 and also energizes contactor Y3 and solenoid Z5.

Energizing solenoid Z5 operates valve V5 to admit oil at the rod end of cylinder T2, causing the hopper to return. At the end of this action the built-up pressure operates pressure switch F4 which de-energizes contactor Y3 and solenoid Z5, allowing valve V5 to center. The operation of pressure switch F4 also energizes contactor Y4 and solenoid Z4, operating valve V4 to admit oil at the rod end of cylinder T1, causing the carriage to return to station A. At the end of this action the built-up pressure operates pressure switch F2, de-energizing contactor Y4 and solenoid Z4, allowing valve V4 to center or attain a neutral position. This completes the operating cycle.

System A3 offers a more efficient and direct method for performing the required function. As we have seen, an automatic operation is initiated by momentarily depressing a push button. The carriage is moved from station A to station B, where the hopper or cradle is tilted and retracted, and then the carriage is returned to station A. This system can be modified to clamp or hold the carriage at station B while the hopper is being tilted and retracted; or additional control can be provided to return the carriage to station A from any stage of the automatic operation. In fact, the system can be modified or expanded to meet any logical requirement for automatic operation.

In any event, the best planned hydraulic system on paper will fall short of its expected performance if the very many details of translating the plan into practical application are not equally well planned.

The details of translating the three systems discussed will be the subject of the next article in this series. This installment should be preserved for continuity.

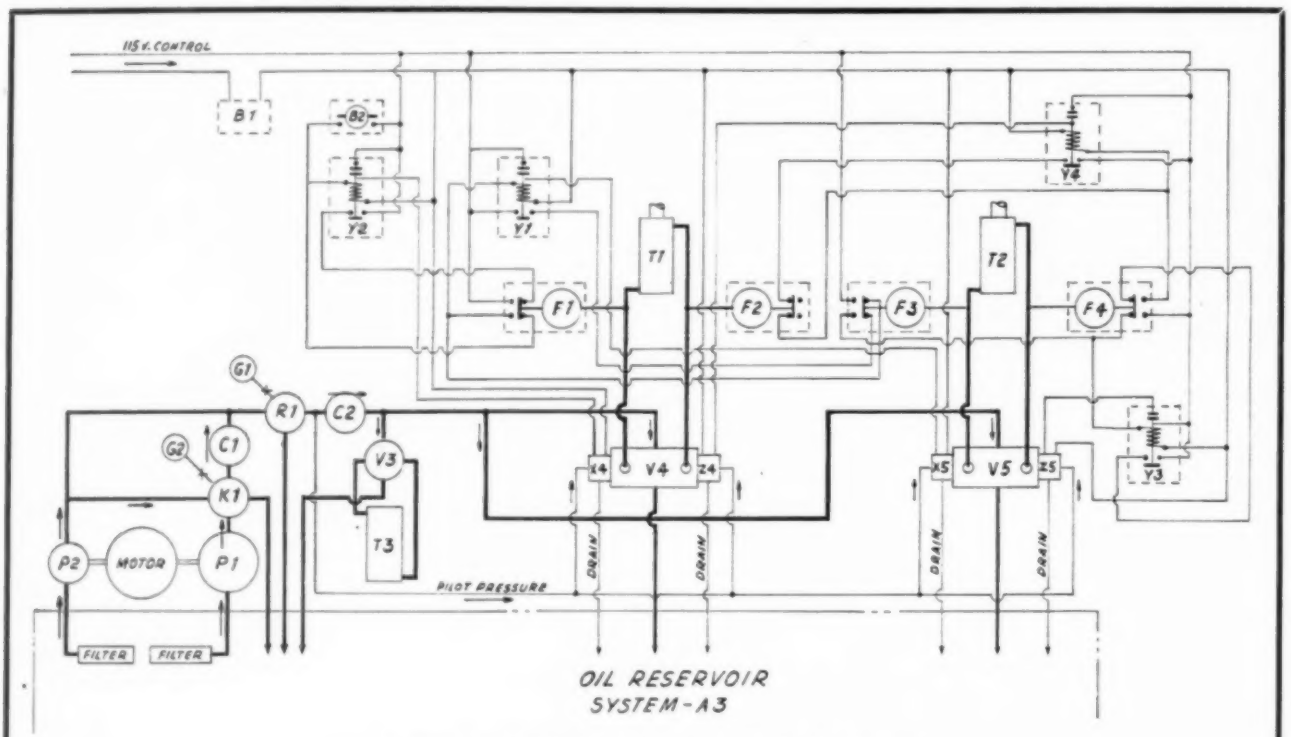

Fig. 3. A fully automatic arrangement provides for the most efficient and positive performance.

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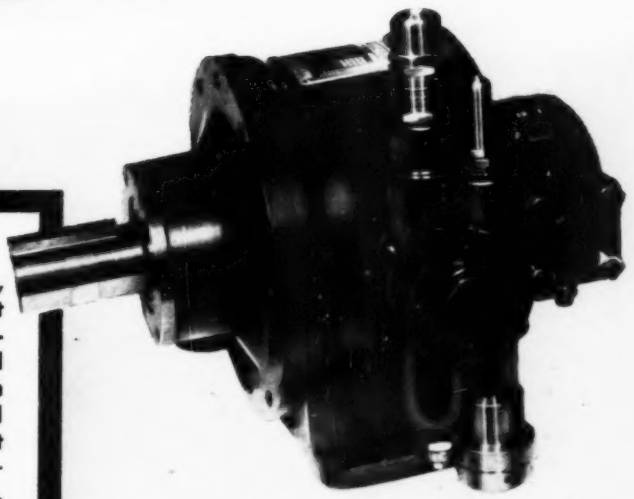
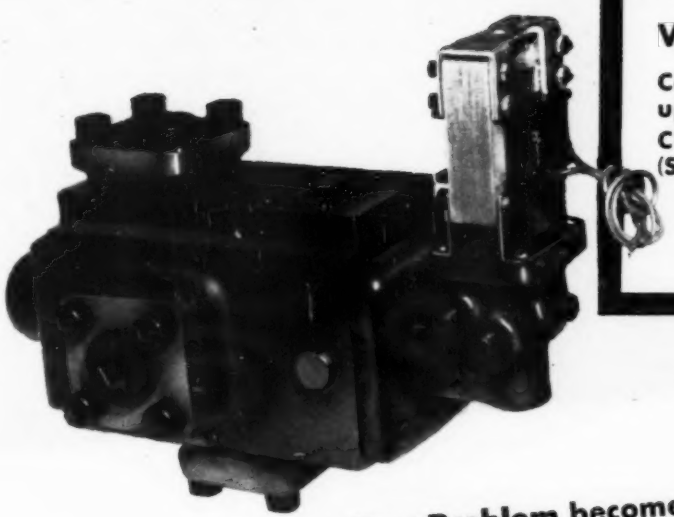


PUMPS •

High-pressure hydraulic pumps—3500 PSI, 0 to 17 GPM at 1200 RPM or 0 to 12 GPM at 5000 PSI. Available with three types of volume control—hand wheel, sliding stem and pressure compensator. Also, available in constant delivery type pumps with identical ratings. Ideal power for Aircraft test equipment, presses, plastics machinery—wherever hydraulic power is required.



VALVES

Complete line of valves for pressures up to 5000 PSI.

Check valves—Relief valves—4-way (Solenoid-Pilot or Manually controlled)

Superdraulic valves are machined from solid castings to assure precision construction.

Your Problem becomes as simple as ABC through the experience of the SUPERDRAULIC engineering staff. Every type of hydraulic installation from aircraft to industrial applications are covered. If you have a hydraulic problem SUPERDRAULIC would welcome an opportunity to sit down and work it out with you.

Superdraulic

HYDRAULIC PUMPS • MOTORS • TRANSMISSIONS • VALVES

SUPERDRAULIC CORPORATION

14256 WYOMING AVE. • DETROIT 4, MICH.

National Metal Congress and Exposition

The 30th National Metal Congress and Exposition will be held in Philadelphia, October 25-29. The central theme of both technical program and exposition will be a Salute to Alloy Steel. Marking 75 years of progress, the entire stage of Convention Hall will be given over to a spectacular dramatization of alloy steel. The technical program of over 100 papers by recognized authorities will cover all aspects of alloy steel.

The Congress and Exposition is sponsored by the American Society for Metals in co-operation with the American Welding Society, the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers and the Society for Non-Destructive Testing.

An outstanding feature will be the presentation of "Distinguished Service Awards" to individuals who, by research, experimentation, improved manufacturing processes, new applications and other means, have contributed to the improvement, development and acceptance of alloy steel.

Over 350 manufacturers and processors of metals and metal products will exhibit.

WHAT TYPE OF PRESS?

(Continued from page 18)

through the pressing and return at a high rate of speed. The mechanical press requires less feeding time as it permits the operator to maintain a natural rhythmic motion.

(c) This press is by far the most suitable for blanking operations as the break through shock is not detrimental to the machine.

(d) With cushion this press has the lowest initial cost for presses equipped with a short stroke.

(e) Requires a smaller motor than hydraulic presses as it is possible to store energy in the flywheel and then dissipate the energy through the pressing stroke.

(f) Easily adapted for roll and transfer feeds and for progressive dies. A mechanical single action press is illustrated in Figure 1.

(g) The mechanical single action press may have maintenance to the same extent as the hydraulic. However, the maintenance of the mechanical press is much less technical.

Disadvantages

(a) The mechanical single action press with cushion has a rated tonnage, which is full tonnage a certain distance (usually ⅛ in) above the bottom of the stroke. Less power is available for work encountered at points above the bottom of the stroke, e.g., a 300 ton, 36 in stroke mechanical press entering a draw 4 in above the bottom of the stroke would have an available tonnage of only 114 tons. At higher points on the stroke the tonnage factor would be even lower.

(b) This press will not adjust itself for stock variations as does the hydraulic. Thicker stock or poor die setting make tonnage settings erratic.

(c) For adjustment of pressure at the four corners of the piece being produced, shimming of the cushion pins is necessary.

(d) The dies must be set with regard for stock thickness. By adjusting the punch too low the press may stick on dead center. This requires a tedious operation of unsticking the press.

(e) The mechanical single action press when used on a draw which is equal to almost half of the stroke, enters the work at the high mid-stroke velocity with the rate of speed of drawing reduced as the punch continues downward. This is in direct contrast to the hydraulic press, which slows up before entering the work, then proceeds to draw at a constant rate, giving the metal a chance to flow to its best advantage.

Mechanical Double Action Presses

Advantages

(a) The mechanical double action press is faster on long strokes than the hydraulic double action press, unless unusual power provisions are built into the latter.

(b) The same time is required for the downstroke and the upstroke.

(c) A smaller motor is required.

(d) The press can be adjusted at the four corners. While the adjustment is not easily made and there is no direct indication of tonnage, it is possible to vary corner pressures more easily than is possible with the press equipped with cushions.

(e) There is no oil leakage and housekeeping is much easier.

(f) While the mechanical double action press maintenance is much more complicated than the mechanical single action, it is much less technical than the maintenance on the hydraulic presses, particularly the hydraulic double action. This advantage is variable, depending on the number of hydraulic presses in the plant and the relative familiarity of the maintenance men with each type.

Disadvantages

(a) The mechanical double action press is very susceptible to breakage of the blankholder arms, the breakage being caused by stock variations, poor die setting and other variables that enter where a locked system is used.

(b) In comparison with the hydraulic double action, much more time and care is required in adjustment of the mechanical blankholder.

(c) The punchholder enters the work at a high rate of speed, the deeper the draw the higher the speed.

(d) Unless equipped with automatic lubrication, there are a large number of bearings, pins, rockers, etc., to be lubricated.

(e) The rated tonnage at midstroke is only a fraction of the rated capacity of the press.

(f) On the mechanical double action press the die setting time is, of course, the greatest of any of the presses being considered. It is necessary to adjust both the punchholder and the four corners of the blankholder so that dies will not bottom and will not fail to do the work. This adjustment must be precise.

The preceding information is general and no attempt has been made to cover small details which may be relatively important in a press selection. However, it is hoped that this discussion and checklists will be useful to individuals and organizations who must make a selection of the type of press they will be able to use most efficiently and economically.

Hydraulics Conference Program

The program of the fourth National Conference on Industrial Hydraulics, which will be held at Hotel Sheraton, Chicago, October 20 and 21, is now complete.

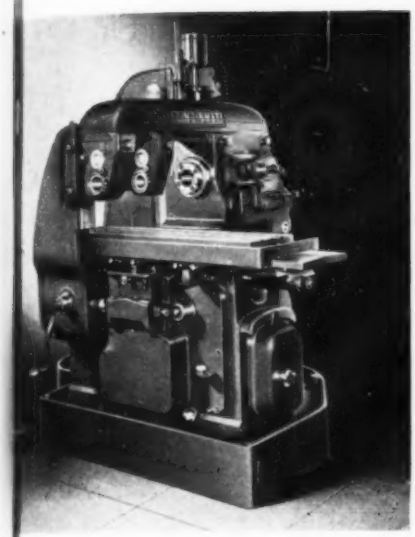
The third conference last year drew over 300 registrants. With the accelerated growth of the industry and the widespread interest in hydraulic actuation and control, an even larger attendance is expected this year.

Engineers who expect to attend are urged to make their reservations early. Professor S. F. Musselman, Technology Center, Chicago 16, is secretary of the Conference.

The Cincinnati Milling Machine Co.

MILLING MACHINES

This the first of a series of data sheets on the hydraulic maintenance of machine tools. Each installment will identify the hydraulic circuits in the machines and act as a guide to the manufacturer's own technical and service literature, with emphasis on the care and maintenance of the hydraulic elements of each type of machine.



No. 2-24 Automatic Rise and Fall Milling Machine (Model ER)

Automatic (reversible) and manually controlled table cycles for up and down milling cuts. Four standard automatic cycles available.

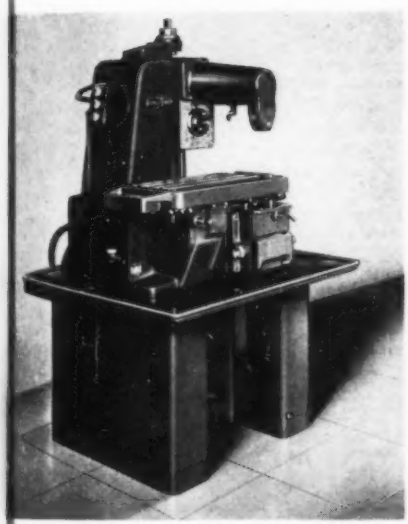
Hydraulic Circuits: Rise and fall mechanism; table reverse; sectional hydraulic pump for fixtures.

Attachments Available: Publication No. M-1554

Service Manual and Parts List Catalog: Catalog No. M-1270-1

Proper Care and Operation: Operator's Instructio: Book, Publication No. M-915-2

SPECIFICATIONS	
style	**plain or duplex**
table working surface	**42x11 in.**
range: longitudinal	**24 in.**
cross (quill)	**3 in.**
vertical, power	**8 in.**
20 spindle speeds	**30-1200 rpm**
taper hole in spindle	**no. 50 std**
16 table feeds	**½-20 in./min**
motor drives: spindle	**3 hp**
feed	**2 hp**



No. O-8 Plain Automatic (Model EA)

Basic machine with or without hydraulic rise and fall mechanism. Without se and fall spindle carrier, machine is exceptionally efficient for simple milling cuts on small parts for which automatic table cycles can be used to advatage. Specifications and features: Publication No. M-1458-1.

Hydraulic Circuits: Vertical traverse of spindle power rapid traverse; independent feed; cycles.

Machine built in two types: (1) spindle carrier fixed; and (2) automatic rise and fall spindle carrier timed with table traverse.

Attachments Available: Cam roller attachment.

Service Manual and Parts List Catalog: Catalog No. M-1241-1

Proper Care and Operation: Operator's Instruction Book, Publication No. M-898-4

SPECIFICATIONS	
style	**plain**
table working surface	**23 11/16x6½ in.**
range: longitudinal	**8 in.**
cross (quill)	**1 in.**
vertical—hand	**6 in.**
20 spindle speeds	**80-3000 rpm**
taper hole in spindle	**no. 40**
16 feeds: standard	**½-20 in./min**
optional, high series A	**1-40 in./min**
optional, high series B	**2-80 in./min**
motor drive: spindle	**1½ hp**
feed and hydr. pump	**1 hp**

Nos. 1-12 and 1-18 Plain Automatics

These two machines are basically production-type millers, but with many convenient and quick set-up features, they are profitable for small lot as well as for long runs. Applications, specifications and features: Publication No. M-1555.

Hydraulic Circuits: Automatic clutch shifting; backlash eliminator; spindle stop.

Attachments Available: Publication No. M-1555-1

Service Manual and Parts List Catalog: Catalog No. M-1196-1.

Proper Care and Operation: Operator's Instruction Book, Publication No. M-849-5

SPECIFICATIONS		
size	**no. 1-12**	**no. 1-1**
table working surface	**29½x10 in.**	**35½x10**
range: longitudinal	**12 in.**	**18 in.**
cross (quill)	**2⅜ in.**	**2⅜ in.**
vertical (hand)	**8 in.**	**8 in.**
centerline spindle to table: max	**10 in.**	**10 in.**
min	**1¾ in.**	**1¾ in.**
16 spindle speeds	**50-1500 rpm**	
spindle nose	**no. 40 std**	
16 table feeds: std	**¾-30 in./min**	
high (extra)	**1½-60 in./min**	
low (extra)	**½-21½ in./min**	
motor drive	**3 hp**	**3 hp**

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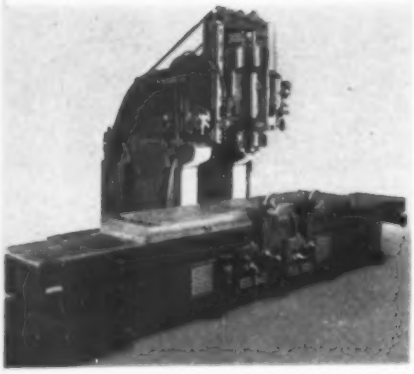
MILLING MACHINES



28" Series Vertical Hydro-Tel

Fast metal removal and handling on wide range of milling jobs with negligible fatigue of manipulation.

Hydraulic Circuits: Table; cross-slide and spindle carrier

Standard Equipment: Catalog No. M-1284-1

Choice of Equipment: Catalog No. M-1284-1

Service Manual and Parts List Catalog: Catalog No. IH-00, Publication No. M-1469

Proper Care and Operation: Operator's Instruction Book, Publication No. M-1048-1

Note: There are also 16" and 36" Vertical Hydro-Tels in the line.

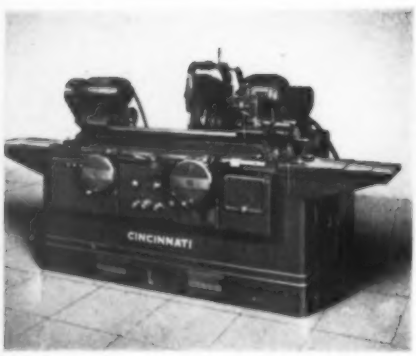
SPECIFICATIONS

size	no. 28-60*
table working surface	83x28 in.
range: longitudinal	60 in.
cross	30 in.
vertical head	14 in.
16 spindle speeds (range	22 to 550, 30 to
optional	52 to 1300, or
spindle nose	1800 rpm
infinite feeds: table	no. 50 std
cross	1-25 in./min
vertical head (extra)	1-25 in./min
motor drive: spindle	1-15 in./min
hydraulic pump	7½ or 10 hp
	5 or 7½ hp

*size no. 28-96 has table working surface 119x28 longitudinal range of 96 in.; size no. 28-120 has su 143x28 in. and longitudinal range of 120 in.; cross vertical head ranges are identical with no. 28-60.

Cincinnati Grinders Incorporated

GRINDING MACHINES



6" and 10"-L Plain Hydraulic Grinding Machines

These machines have outstanding and exclusive features for grinding precision cylindrical work; they may be used for tool room lots or high production runs; for traverse and infeed grinding.

Hydraulic Circuit: Table traverse

Standard Equipment: Catalog No. G-566

Attachments Available: Catalog No. G-566

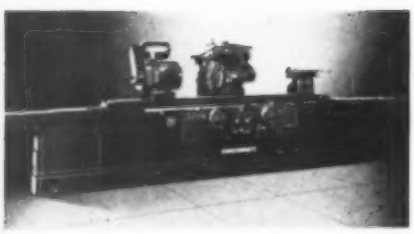
Service Manual and Parts List Catalog: Publication No. G-569

Proper Care and Operation: Operator's Instruction Book, Publication No. G-539

SPECIFICATIONS

size	6 in.*
swing over table	6 15/16 in.
two lengths each size	18 and 30 in.
* four work speeds	97 to 395 rpm
headstock and footstock centers	no. 10 B & S
infinite table traverse speeds	3-240 in./min
table tarry adjustment	0-5 seconds
two hand table traverse rates	1/10 and 15/16 in.
two hand cross traverse rates	.050 and .125 in.
grinding wheel supplied	24 x 2 x 12 in.
motor drives: grinding wheel	7½ hp
headstock	½ hp
hydraulic	1 hp

* speeds listed are for 60 cycle, 1200 rpm motor.
* size 10 in.-L has 10⅝ in. swing over table and speeds of 66 to 268 rpm; other specifications are ident



10" and 14"-L Plain Hydraulic

These center-type grinders are capable of rapidly producing exceptionally fine finishes and close tolerances of accuracy on any production basis.

Hydraulic Circuit: Table traverse, servo controlled

Standard Equipment: Catalog No. G-572

Attachments Available: Catalog No. G-572

Service Manual and Parts List Catalog: Publication No. G-569

Proper Care and Operation: Operator's Instruction Book, Publication No. G-493-1 (10" machine)

SPECIFICATIONS

size	10 in.*
swing over table	10 15/16 in.
five lengths each size	18, 36, 48, 7
	96 in.
work speeds, 3.8 to 1 ratio	76-292, 62-237
	46-172 rpm
headstock and footstock centers	no. 12 B & S
infinite table traverse speeds	3-220 in./min
table tarry adjustment	0-5 sec
accuracy of table reversal	.004 in.
hand table traverse	1 in./rev
grinding wheel supplied	30 x 3 x 20 in.
motor drives: grinding wheel	15 hp
headstock	¾ or 1 hp
hydraulic	1½ hp

*14 in.-L has 14 15/16 in. swing over table; other specifications identical with 10 in.

The literature listed was accurate for the machines it treats at time of issue. However, design changes may have made some data obsolete in certain cases. Consult with the manufacturer's nearest district office or distributor.

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GRINDING MACHINES

12" Hydraulic Universal

Finishes and accuracy above accepted standards for tool room grinding operations, without special preparation. Three functions—table traverse, work rotation and coolant flow—are controlled by the start-stop lever.

Hydraulic Circuit: Table traverse. Independent unit construction of hydraulic control elements

Standard Equipment: Catalog No. G-486-4

Attachments Available: Catalog No. G-486-4

Service Manual and Parts List Catalog: Publication No. G-547

Proper Care and Operation: Operator's Instruction Book, Publication No. G-489-2

SPECIFICATIONS	
size	12 in.
three lengths each size	36, 48, 72 in.
infinite work rotation speeds	55-500 rpm
headstock and footstock centers	no. 9 B & S
headstock spindle nose	5 in. lathe std
infinite table traverse speeds	3-240 in./min
grinding wheels supplied	14x1 ½x5 in. 14x1x5 in.
motor drives: grinding wheel	3 hp
internal	1 hp
headstock	¾ hp
hydraulic	1 hp

14", 16" and 18" Hydraulic Universal

These machines have all features required for grinding a variety of precision work—straight cylindrical, taper, bevel, shoulder and chuck work, face and rotary surface grinding. They handle internal work with the Hinged Internal Grinding Attachment (standard equipment).

Hydraulic Circuit: Table traverse

Attachments Available: Catalog No. G-474-3

Service Manual and Parts List Catalog: Publication No. G-547

Proper Care and Operation: Operator's Instruction Book, Publication No. G-502-2

SPECIFICATIONS	
size	14, 16, 18 in.
three lengths each size	36, 48, 72 in.
infinite work rotation speeds	25-225 or 40-360 rpm
headstock and footstock centers	no. 10 B & S
headstock spindle nose	6 in. lathe std
infinite table traverse speeds	3-220 in./min
grinding wheels supplied	14x1 ½x5 in. 14x1x5 in.
motor drives: grinding wheel	5 hp
internal	2 hp
headstock	¾ or 1 hp
hydraulic	1 ½ hp

Catalogs issued by these companies contain machine descriptions, design features, specifications, standard and extra equipment and, in many cases, suggested applications. Catalogs are supplied gratis except to used machinery dealers and rebuilders.

Service Manuals and Parts List Catalogs contain very detailed instructions on installations and adjustments, individual machine elements, dismantling procedures, lubricating notes and maintenance hints as well as a complete parts list.

Operator's Instruction Books, as the name implies, contain information essential for the proper operation, and lubrication of specific types of machines, in addition to instructions for external adjustments.

Service Manuals and Operator's Instruction Books are supplied with each machine as purchased and duplicates are supplied on request. For those not affiliated with a company, a nominal charge of $2.00 for Service Manuals and $1.00 for Operator's Instruction Books is made.

Copies of literature may be obtained by company operating and maintenance supervisory personnel by writing on their company letterhead to Cincinnati Milling Machine Co. or Cincinnati Grinders Incorporated, Cincinnati 9, Ohio, giving name and size of machine and the serial number.

All Cincinnati machines and attachments are protected by issued and pending United States and Foreign patents.

HYDRAULICS AND THE GUIDED MISSILE

(Continued from page 11)

(1) A time lag always exists between a signal and the response to the signal
(2) Various ratios are not actually proportional
(3) Mechanical movements and electrical quantities are limited
(4) Weight, size and shape of units are restricted
(5) System components will frequently become unworkable at climatic extremes, and
(6) The maximum power available is often limited.

Since a proportional control system can be represented by a simple spring and mass associated with a certain amount of viscous damping, it is evident that inertia, spring constant and coefficient of damping become primary terms in the equations which pertain to the system. Inertia, aerodynamic coefficients and similar parameters must be considered in the equations pertinent to any guided missile. In a simple spring and mass system, the "natural undamped frequency" of such a system is a common term. This natural frequency is given by the equation

$$w_n = \sqrt{\frac{k}{M}}$$

where k is the spring constant and M is the mass. Similarly, the natural frequency of a missile having proportional control is comparable. This natural frequency is given by

$$w_n = \sqrt{\frac{c}{I}}$$

where c is the effectiveness of the control surface about the axis under consideration and I is the moment of inertia about that axis. Typical units of c would be pound-feet per radian. Because of the damping and other considerations, the missile might not actually oscillate at this frequency.

Time Lags

Time lags that occur in the controlling servo are the primary reason for complications in such equations; time lag exists in every circuit and movement.

For example, should an electrical voltage be generated which indicates an error in the direction of flight, the voltage must be relayed to an amplifier. Because of inductances in the circuit, the amplifier receives the signal a few thousandths of a second after the error occurred. The amplifier takes upward of a few microseconds to amplify this signal. A few thousandths of a second later this voltage will operate a small control device. After another few thousandths second the main power unit will start to operate. In another fraction of a second the control surface will finally begin to move. However, this movement occurs only after a time lag ranging from a few hundredths of a second to a more substantial time gap after the original error signal was initiated. In the meantime, the error may have increased considerably. It is clear that any control mechanism which cannot move the control surface before the missile can respond appreciably to an assumed error in the position of the surface cannot be expected to exert control. If a one or two degree deflection inadvertently remains in the control surface, some missiles can turn completely over in a few hundredths of a second. It is evident that the time lag problems in servos can assume large proportions.

The Size Factor in Control Design

The time required for a missile to respond to a movement of a control surface is directly a function of the mass of a missile and inversely a function of the effectiveness of the control surfaces. As a missile becomes smaller in size, the problems of building an automatic control become increasingly more difficult. Working space is at an absolute premium. For example, one requirement could demand the building of a complete electronic circuit containing upwards of fifty tubes in a space of less than 75 cubic inches. At supersonic speeds, it requires relatively large forces and torques to move a control surface into the airstream. Considerable research and a high order of skill are necessary to design a unit sufficiently powerful to move a control surface in a fraction of a second and small enough to require only a few cubic inches of space.

Error Detection Essential

All control systems and related servomechanisms rely upon the detection of an error to operate in the proper manner. In guided missile work, finding the error is in itself a difficult task. For instance, the basic problem of discovering or creating a device that will accurately indicate a direction for any length of time is not as easy as it may appear. A magnetic compass is rendered useless by the caliber of accelerations present in the flight of a missile and a gyro compass drifts off course in a short time. For navigational and general stabilizational purposes, it is often necessary to know the true vertical from the earth at all times; it is difficult to build a precise, vertical indicator. Frequently too, instruments which will perform satisfactorily in the laboratory cannot tolerate the vibration and acceleration of a missile in flight and certainly will not survive the shock of launching.

The Computing Circuit Problem

Extensive computing circuits are often incorporated into the control systems of guided missiles. Such circuits are called upon to add, multiply, integrate and perform numerous other calculations for guidance purposes. It would be highly desirable to create a control system which would cause the missile to perform in the desired manner without reference to any exterior influence. Such a

system is referred to as a "inertial reference" system. It is possible to detect the following quantities without reference to external influences and without knowledge of position with respect to the earth:

(1) Direction and value of linear acceleration
(2) Direction and value of angular accleration, and
(3) Direction and value of angular rotation.

It is not possible to have direct detection of the following quantities:

(1) Direction and value of linear velocity, and
(2) Linear position.

In an inertial reference system it is necessary, among other things, to integrate linear acceleration once to obtain linear velocity and twice to obtain linear position. Such circuits would be called upon to integrate with utmost accuracy and integrate over long periods of time. Design of such devices progresses slowly and involves a considerable effort, time and cost. The foregoing is representative of but one of the many problems in the design of computing circuits.

Hydraulic Controls

Hydraulic mechanisms have won a place in many applications associated with missile work. Fluid affords a means of transmitting large amounts of power from a central position to several separate stations; there is little energy lost in the transmission of this power; control is positive in nature; and it is possible to sustain forces without expending further energy. Furthermore, large power amplifications are possible; it is also possible to govern a considerable amount of horsepower with a few watts of control. Hydraulic controls can easily be tied into electrical networks and can be designed to perform almost any kind of work.

At the present time there are four reasons why hydraulics are not used in certain types of guided missiles:

(1) Lack of small, efficient power reservoirs or generators
(2) Unreliable operation at climatic extremes
(3) Tendency of hydraulic systems to leak, and
(4) Storage problems.

Considerable research and development is being conducted in the hydraulics field in an attempt to create small, efficient hydraulic reservoirs of power to compete with batteries and to eliminate the sticking and freezing of control valves and other components at climatic extremes. Under the latter conditions, failures do not often occur from a fault or failure of the oil itself, but rather from the "freezing" of moving parts which operate under close tolerances.

Hydraulics has an excellent opportunity of becoming the leading workhorse for modern guided missile control systems.

Battery of 18 Batching Hoppers in a large food processing plant.
NOPAK Reciprotrol Valve and Model E Cylinder, on each hopper, operate shakedown mechanism automatically.

AUTOMATIC "SHAKE-DOWN" for 18 Batching Hoppers is NOPAK Operated . . .

This block-long battery of hoppers is used for measured mixing of product ingredients. Running thru each hopper is a rotating shaft, with paddles, connected to a NOPAK Model E Hydraulic Cylinder. As the cylinder reciprocates, the paddles shake down the dry ingredients which drop into glass-enclosed weighing batchers. Each of the 18 cylinders reciprocates 20 times per minute, 18 hours a day. This continuous reciprocating action is governed by 18 NOPAK Reciprotrol Valves. The entire mixing process is fully automatic . . . controlled from a central switchboard by 2 operators.

NOPAK Reciprotrol Valves can help you achieve automatic control of cylinder action in your plant, or in your product. Write for Illustrated Bulletin.

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VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

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High Pressure HydrOILic PUMPS

in both fixed and variable stroke types

A NEW simplified design eliminating bulk, features the Denison High Pressure HydrOILic pumps—resulting in a more compact and rugged unit. These pumps are so efficiently designed, they are virtually *one solid piece of metal*, and require but a minimum of space for installation. They are efficient and quiet in operation, even at highest pressures.

Constant displacement models are available in three sizes: 6, 17 and 32 gpm, for pressure to 5000 psi. Choice of face, flange or foot mounting types. Variable displacement models can be furnished in three sizes: 6, 17 and 32 gpm, with three types of displacement controls: handwheel, pressure compensating and pressure centering. Foot, face or flange type mountings are available. Write for details.

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DENISON EQUIPMENT for APPLIED HydrOILics

VALVES • FLUID MOTORS • PUMPING UNITS • HydrOILic PRESSES

Applied HYDRAULICS DIGEST

Abstracts, summaries and listing of articles on hydraulic and associated applications in industry; reports on prepared papers, talks and discussions of special interest to the hydraulics field.

What the Air Force Wants in Nonflammable Hydraulic Fluids

E. M. Glass, *SAE Journal*, v 56, September 1948, pp 55-59.

This is a summary of the discussion at recent meetings of the SAE Aircraft Hydraulics and Pneumatic Equipment Committee. Mr. Glass is chief, Petroleum Products Unit, Material Laboratory, Engineering Division, Air Material Command.

Interest in less inflammable hydraulic fluids by the United States Air Force dates back to approximately 1943 when a British survey concluded that between 2 and 3 percent of all aircraft lost by fire in combat were the result of hydraulic fluid fires. The National Defense Research Council set up a "fire-proof" fluid program under the direction of Dr. M. R. Fenske.

Several specifications were written to describe less inflammable hydraulic fluids for aircraft use: (a) Navy Specification 51-F-22 (Aer), a water-ethylene glycol base fluid, commonly called "Hydrolube", and (b) SAE Aircraft Material Specification (AMS) 3150, an interim fluid for commercial aircraft required to be compatible with present hydraulic system materials and fluids. This latter specification was formerly distributed as the Aircraft Industries Association Proposed Specification for Non-Flammable Type Hydraulic Fluid.

Unfortunately, the trend in fluids developed to date has been to sacrifice performance of the fluids to achieve varying degrees of improved flammability characteristics. The Air Force has insisted that there be no compromise with performance in any less flammable fluid adopted for its use. The remainder of this paper outlines the minimum requirements for a less flammable hydraulic fluid which is acceptable to the USAF.

Industrial Research

T. A. Boyd, *ASTM Bulletin,* August 1948, pp 55-59.

In his presidential address before the American Society of Testing Materials in June, Mr. Boyd reviews the advances made by industrial research since 1918. In 1918 about 300 companies had research laboratories of some kind and in 1920 some 7000 persons were engaged in industrial research. By 1930 over 1600 industrial research laboratories were in operation. Today the number is over 2500 and over 135,000 specially trained technicians are creating new processes and products and are improving established techniques of manufacturing and marketing. A number of present day major industries which either did not exist or were considered visionary 30 years ago, are cited to indicate the direct influence of research. The radio and electronic, the automotive, aviation, the synthetic textile and the medical fields are pointed out.

Well organized and directed industrial research has been good business. Charles L. Reese of the du Pont Company is quoted to the effect that the $1,200,000 spent by his company on research from 1912 to 1915 resulted in a saving of $14,000,000. R. P. Russell, then president of the Standard Oil Development Co., in the same vein stated that for each thousand dollars spent for research and development more than fifteen thousand dollars has been added to the profits of stockholders.

The technological developments have displaced workers in industry but, at the same time, they have created new industries and new jobs in old industries to fully absorb such workers. Approximately 20 percent of all workers were employed in the manufacturing and mechanical industries in 1918 and the overall percentage has remained steady in spite of the major changes made in manufacturing techniques.

The direction or management of industrial research has become a profession of importance.

Build Service Into Your Compressed Air System

Extract, from "Compressed Air Handbook", *Operating Engineer,* v 1, August 1948, pp 40-41.

This extract covers the factors to consider in working out a compressed air installation. The load factor, leakage, number of compressors, compressor location, loading control and distribution system are the major points discussed. The interesting point of the very low average load factor is brought out—in one shop the actual air consumed was only 15 percent of the full-time rated requirements, in a large plant the actual work load was only 7.6 percent, based on the total tools in operation, plus stock and reserves. Multiple and standby compressors are

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New! VARIABLE VOLUME OIL HYDRAULIC VANE TYPE PUMP

ANOTHER RACINE HYDRAULIC ACHIEVEMENT — the new Model J Variable Volume Oil Hydraulic Pump. Compact Vane Type design allows installation of this pump in a space as small as 6" x 6". It will deliver 1000 pounds pressure per square inch and will maintain a 90% volumetric efficiency.

Variable Volume feature allows horsepower requirement of system to be held to demands of the maximum load. Racine Hydraulic engineers welcome the opportunity to review your needs and make recommendations for complete hydraulic circuits. Write for Catalog P-10-C. Address RACINE TOOL AND MACHINE CO., 1774 STATE ST., RACINE, WISCONSIN.

OUTSTANDING FEATURES

ADJUSTABLE VOLUME — Pump can be set to deliver exactly the proper volume of oil for any given job.

ACCURATELY BUILT—All parts precision made. Accurately ground vanes of special steel are self-compensating for wear. Rotor shaft mounted in anti-friction bearings. Entire pump is self lubricated.

LOW COST—Quantity production and standardization of parts make possible low cost that compares favorably with constant volume non-adjustable pumps.

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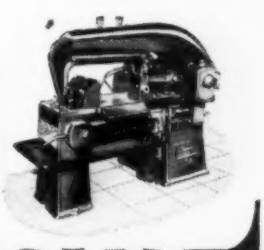
Variable Volume Pumps with either manual, mechanical, hydraulic or electrical volume control are available in capacities to 30 g.p.m. at pressures of 50 to 1000 lbs. p.s.i. Four-Way, Balanced-Piston Sleeve-Type hydraulic valves are also available in a wide range of styles and portings. Sizes ⅜" to 1½" I.P.S., lever, foot, pilot or solenoid operated.

RACINE *Hydraulic* METAL CUTTING MACHINES

If you have a metal cutting job whether it be soft aluminum or hard tool steel, tubing or bar, Racine has a saw in its complete line that will do the job. Sizes range from 6" x 6" to 20" x 20". Ask for catalog No. 12.



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recommended for small continuous demands and maintenance work when the plant is idle. Central plant or divided units near the air using equipment is stated as good practice. Good, practical rules for laying out a piping system are given.

Applications of Hydraulic Transmissions

R. M. Schaefer, from a paper delivered at SAE National Tractor and Diesel Engine Meeting, Milwaukee, Wis., September 7-9, 1948.

This has been digested from the preprint. The author reviews the applications of hydraulic transmissions in two periods: (a) to the end of the War, and (b) postwar. He credits G.M. Coaches with the first application in 1931. The first hydraulic transmissions providing a converter with automatic shift into direct drive were installed in 1938. This was a Spicer Model 90, with which approximately 14,000 coaches were equipped. Advantages were better engine arrangement, more passenger space and the elimination of the need for a conductor. In 1940 the fluid drive was introduced by Chrysler and the Hydramatic by Oldsmobile and Cadillac. The Hydramatic is named as the first full-torque-shifting, fully automatic transmission to be built on a production basis. Reduction in fatigue and smoother starting acceleration were the principal advantages.

About the same time Allis-Chalmers started the application of a torque converter in their largest crawler tractor. Interrupted by the war, the company brought out a postwar model, their Model HD-19, equipped with a torque converter as standard.

The Ordnance Department, about 1940, accepted the Hydramatic equipped twin Cadillac engine as standard for the M5 light tank and the Torqmatic transmission (three speed semi-automatic, full torque shifting transmission equipped with a torque converter) for prime movers and heavier tanks.

The hydraulic transmissions developed postwar include: the GM hydraulic marine gear; the Buick Dynaflow transmission; and the G.M. Converter.

Hydraulic transmissions for the tractor industry are discussed in terms of tracklaying and wheel vehicles. For tracklaying tractors mechanical transmissions now being used are rather complex. The torque converter permits engine operation at a higher power factor and provides more power under variable load conditions with a minimum of attention on the part of the operator. Based on the success of the Allis-Chalmers HD-19 and the acceptance of the converter in Ordnance equipment, Mr. Schaefer believes that it is only a matter of time till converters in one form or another will be widely used in tracklaying tractors.

In wheel tractors the picture is very different. Most such tractors are small; the average price of farm tractors in 1947 was $815.00. The average farm tractor is operated only a few hundred hours each year and quite often at a low power factor; it is usually started in the gear that is to be operated. Hydraulic applications to wheeled tractors is considered to be a remote possibility. He summarizes the factors to be considered in the applications for hydraulic transmissions as new approaches for improved performance and increased work capacity.

Development of an Air-Operated Force Measuring System

A. A. Markson and **R. W. Williams,** *Trans. A.S.M.E.*, May 1948, v 70, pp 271-278.

The force measuring system described in this paper involves the use of a non-metallic flexible diaphragm as a null-deflection, frictionless measuring piston. This is accomplished by using a simple auxiliary positioning pneumatic relay. A viscous stablizing dampener is described as a part of this setup. Because this system is now used in test measurements for cradle dynamometers, turbojet engines, rockets and guided missiles, some essential information on the evaluation of this system is included.

BOOK REVIEW

What Electronics Does

Vin Zeluff and John Markus. *Associate Editors of Electronics. First Edition, 306 pages, 5½ x 8 inches. Published by McGraw-Hill Book Company, Inc. at $3.00.*

A practical, easy-to-read description of the many versatile jobs that electron tubes are doing in the industrial world. Whether you are a production head seeking new and cheaper ways of manufacturing your product, a sales executive interested in new markets, a research engineer looking for answers or just an average person seeking up-to-date information on this field, you will find this book interesting and valuable. Of special interest are chapters on flaw detection in pipes, processing and testing of metals, production machinery speed and cycle control and safety devices for operation of dangerous machines and production processes. Photographs, drawings and understandable explanations are used in describing over 400 examples of electronic applications. For a basic understanding of the limitations and possibilities of electron tubes in industry, this book should prove extremely helpful.

The Hoover Co., North Canton, Ohio, recently celebrated its 40th anniversary. Over 7,000,000 vacuum cleaners were made and sold by this company during that period.

New PRODUCTS

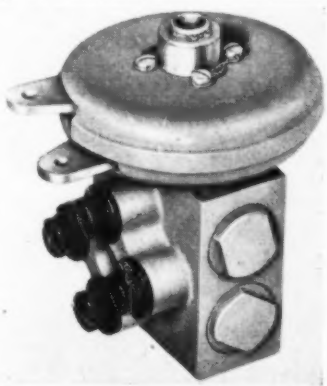
For additional information on any of these products, mark the end key numbers on the card bound in this issue and mail the card.

Variable Speed Transmission

A hydraulic variable speed transmission of the multiple piston, constant torque type is available from Portman Machine Tool Company. It has a maximum rating of 1 hp but it may also be used with a ½ or ¾ hp motor. This Model T-1 transmission has a speed range of zero to 1200 rpm and a maximum torque of 52.5 lb-in. at all speeds. Handwheel control is standard but special controls can be supplied as required. The unit is entirely self-contained and no tanks or sumps are required. Use Business Reply Card, NP-1.

Selector Valve

A new follow-up selector valve for manual or automatic operation is announced by Electrol, Incorporated. This valve can be adapted to mechanical hydraulic systems for such applications as maintaining equal tension, multiple brake actuation, furnace control, steering devices and marine and machine controls. It is light in weight, easy to install and is available



in sizes to meet specific requirements. Use Business Reply Card, mark NP-2.

Electronic Tubes

Radio Corporation of America, Tube Department has available two new klystron oscillators of the single-resonator type. They are useful as a frequency modulated source in low-power transmitters for relay applications, as local oscillators in microwave analyzers and as pulse-operated oscillators for testing circuit response. One type is designed for 6000 to 7000 megacycles and the other for 3800 to 4500 megacycles. Both types have a useful power output to 100 milliwatts. Use Business Reply Card, mark NP-3.

Air Conversion Unit

Paragon Metal Products recently announced a new air conversion unit for converting any

of the popular size hand operated presses into air presses. This unit is complete and ready to use and can be installed in a matter of minutes. Models are made to fit presses of various size and shape of ram. This unit has a 4 in diam cylinder with a 2½ in stroke, a ¾ in ram and a power factor twelve and a half times that of the line pressure. Use Business Reply Card, mark NP-4.

(Continued on next page)

USE "O" RING SEALS

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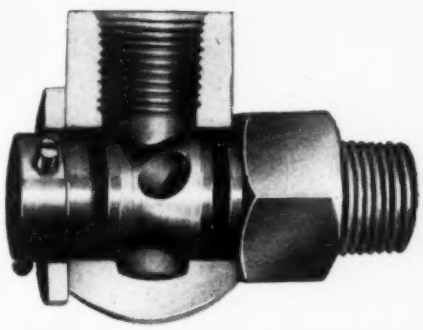
FOR SIMPLICITY • RELIABILITY
LOW COSTS • SPACE SAVINGS



Look at this simple, 4 in 1 swivel union made by MAYSON MANUFACTURING COMPANY of Detroit, Michigan, which may be used as an elbow, union, swivel or banjo fitting. It is made in steel or brass for air, oils, water or hydraulic fluids under vacuum or pressures to 1500 P.S.I.

Note that the use of twin "O" Ring Seals eliminates stuffing boxes and compression packings, compacts the design, reduces weight, reduces costs and enables the union to be broken by hand without the use of tools.

This is another example of how your problem could be solved by using modern "O" Ring Seals.

• Investigate "O" Ring Seals for your packing problems. Consult the "O" Ring pioneers. Send for our "O" Ring Handbook. It's free — no obligation.

PLASTIC and RUBBER Products, Inc.

Dept. 1, Oakridge Drive, Dayton 1, O.

Solenoid Valve

General Controls produce a solenoid valve for oil and air service to 1000 psi at temperatures to 400 F. This series is designated K-10. Positive operation is insured by the adequate solenoid power available. The internal valve assembly is removable for cleaning and inspection. Normally open or closed types for ac or dc service are available. Use Business Reply Card, mark NP-5.

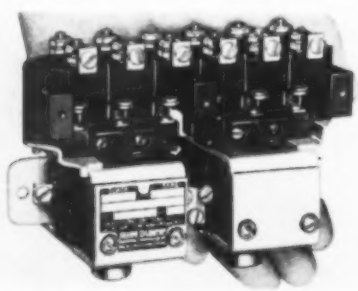
Air Starters

A new line of air starters has been announced by Gardner-Denver Company. A feature of

this 5-cylinder design is an air actuated starter pinion that automatically engages the ring gear of the motor a split second before the starter begins to crank. High torque and the elimination of costly battery maintenance and replacement are some of the advantages of these air starters. Five sizes are offered covering a range from 3 to 15 hp on 100 psi line pressure. Use Business Reply Card, mark NP-6.

Reversing Contactors

New small ac and dc reversing type magnetic contactors are available from Square D Company. They provide a safe



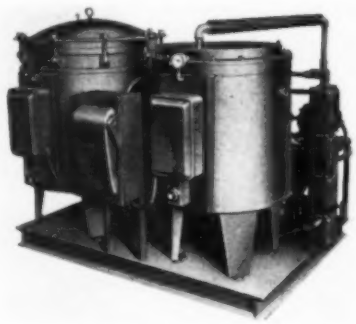
and economical means for starting, stopping and reversing small motors used in connection with mechanical speed changers, valve operation and a variety of related applications. They are both suitable for operation with motors rated at not more than ¾ hp. Extreme compactness and straight line solenoid action are features of this design. Use Business Reply Card, mark NP-7.

Metering Valve

A micrometer thread metering valve for delicate flow control is offered by Carpenter Manufacturing Corporation. It is designed for operation on circuits up to 500 psi and is available in ⅛ and ¼ in sizes. Pipe threads, straight threads, tube machinings or unions are offered. Use Business Reply Card, mark NP-8.

Oil Purifier

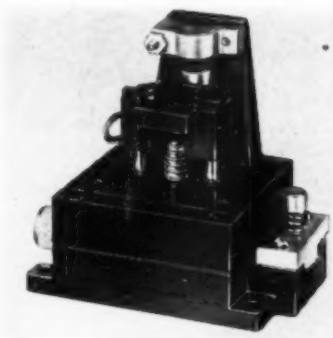
The U. S. Hoffman Machinery Corporation, Filtration Division produces a portable self-contained unit for the purification of different type oils including hydraulic. The unit consists of a cartridge filter and a vaporizer mounted on a common base and is complete with all necessary electric and pump connec-



tions. Filter and vaporizer may be operated independently or together. Capacities range from 50 to 600 gph. Complete purification of used oil is possible with this unit. Use Business Reply Card, mark NP-9.

Pneumatic Timer

The American Controller Company has developed an extremely accurate pneumatic timing relay for use in industrial control applications where a delayed circuit is required after energizing or de-energizing of time sequence operations. This unit is adjustable from ½ second to 5 minutes or longer if required. It can be easily mounted in any position and attached to a contactor or it is possible to actuate the timer by mechanical or magnetic means.



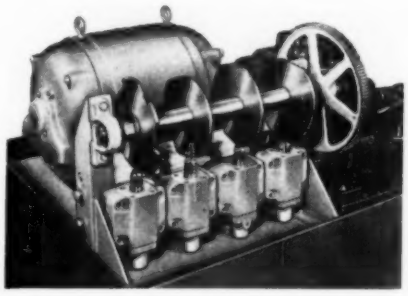
Other models are furnished with snap-action switches. Use Business Reply Card, mark NP-10.

Quick Couplings

A new series, the P-1800, has been added to the line of quick couplings for fluid and air lines manufactured by the E. B. Wiggins Tool Co., Inc. The couplings are made of aluminum and are corrosion resistant, leak-proof under vibration and provide automatic shut-off on one or both sides when uncoupled. Making and breaking the connection is a one-hand operation. This series is available in ⅜ and ½ in taper pipe thread in sockets and plugs and ⅜ and ½ in hose shank sockets. Use Business Reply Card, mark NP-11.

Mechanical Brain

A mechanical brain manufactured by Hufford Machine Works, Inc., can be used for timing repetitive motions to multiple ram installations utilizing hydraulic cylinders. It was originally designed for use with Hufford hydraulic presses but



is now available for a wide variety of hydraulic equipment applications. The cams are driv-

en by a motor through a hydraulic transmission and are mounted on a single shaft. Number of cams is variable. Use Business Reply Card, mark NP-12.

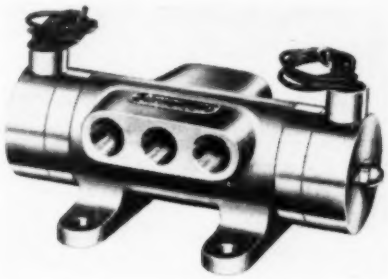
Time Delay Relays

New ac and dc time delay relays are available from A. W.

Haydon Company. These relays have an ingenious planetary differential and capstan type clutch mechanism designed to drive the switch actuating mechanism. This capstan clutch allows amplifications of forces that permit the use of relatively small electromagnets. Almost any time delay interval is possible because of the reliable ac and dc timing motors incorporated. Use Business Reply Card, mark NP-13.

Solenoid Control Valve

Modernair Corporation has developed a new model in their line of CV air control valves. Compact size, "O" ring packings and 4-way type design are features of this valve. Designed for operation on line pressures of 150 psi, coils are furnished for 110, 220 and 440 volt operation.



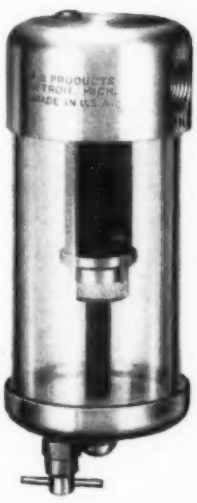
Use Business Reply Card, mark NP-14.

Portable Pump

A new portable, self-contained pump model P-182, driven by an electric motor is offered by Blackhawk Mfg. Co.

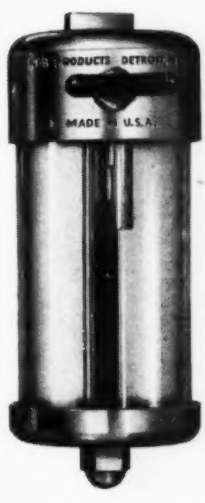
The pump is of the wobble-plate type with four pistons that deliver to 10,000 psi for intermittent service and 5000 psi for continuous service. The electric motor is an especially built vertical type with flange mounting. To operate the unit it is only necessary to plug into a 110 ac circuit. Use Business Reply Card, mark NP-15.

The New Outstanding M-B AUTOMATIC AIR-LINE FILTERS *and* LUBRICATORS



The Filter shown at left is equipped with RIBBON TYPE FILTERING ELEMENT . . . Removes solids 10 microns (.00039") and larger . . . It is a radical departure from general practice, bowl being a transparent plastic; consequently all foreign matter filtered from the air-line is clearly visible, eliminating guess work as to when filtering element should be cleaned or bowl drained . . . There is NO WATER, DIRT OR OIL in compressed air that has passed through this filter . . . Dirt can be removed from edges of filtering element by removing vent plug in the head and opening drain cock in bottom of bowl, then blow-out with air nozzle.

The Lubricator shown at right affords positive lubrication of TOOLS, MACHINES, CYLINDERS, etc. operated by compressed air . . . Method of metering oil from bowl into air-line is POSITIVE and DEFINITE. *Quantity delivered is the desired amount and no more* by means of sight drop feed in indicator tube . . . Feeds oil automatically and continuously only when equipment is in operation . . . Bowl can be filled while equipment is operating . . . An Automatic Venturi Valve permits a limited amount of air to be passed with efficient oil pick-up; when necessary to pass a large volume of air, valve automatically opens, allowing it to pass through . . . The bowl is of transparent plastic, oil level visible at all times.



These devices can be used as separate units or in combination.

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This outstanding equipment warrants your investigation from both a functional and appearance standpoint . . . It will enhance the appearance of your equipment rather than detract from it.

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Useful Literature

The publications listed are available without charge. Mark the initial key number on the card bound in this issue and mail.

25. Rotary Pumps . . . Catalog 949, recently issued by George D. Roper Corporation, reviews the rotary pumps they produce for the manufacturing, marine and process industries. Of special interest are series K and series H pumps for hydraulic service. Series K is designed for pressures to 150 psi and is available in sizes from ¾ to 5 gpm; series H is designed for pressures to 1000 psi and is available in sizes from 10 to 75 gpm. Motor driven units are offered in all types. Each pump type is well illustrated and described. Examples of special-built hydraulic pumps are included.

26. Hydraulic Drives . . . A complete engineering data file on hydraulic drives has been prepared by the Hydraulics Division, Rockwell Manufacturing Co. The Rockwell hydraulic drive consists of a pump and one or more fluid motors, each of Rotocycle design. A four-way distributing and reversing valve is automatically positioned by the "Hydro-syn" governing system to maintain constant predetermined speed. Hydraulic drives in speed ranges up to 5000 rpm and in sizes from fractional to 125 hp are shown with complete specifications.

27. Air-Oil Cylinders . . . Logansport Machine Co., Inc., reviews, in Catalog 471, the air-powered, oil regulated cylinders they produce. The fast, economical operation of air and the smooth, uniform controlled regulation of oil are combined in these cylinders. Five types of mounting are offered with bore sizes ranging from 3 to 8 in and strokes to 5 ft. In addition types of power movements, installation methods, typical application and available accessories are shown.

28. Hose Assemblies . . . High and low pressure hydraulic hose assemblies produced by Eastman Mfg. Co. are reviewed in Catalog No. 47. Pressed-on couplings, renewable couplings, adapter unions, spring guards, hose and replacement parts are included. Coupling sizes vary from 3/16 to 2 in for pressures to 5000 psi and hose available in the same sizes can be obtained in wire braid, rayon braid and cotton and spiral wire styles. In addition to a section on how to install hydraulic assemblies, construction detail drawings and specifications are included for each type of unit.

29. Precision Switches . . . Bulletin No. 50, in the form of a handy pocket-size booklet, describes some of the switches produced by Micro Switch Division of First Industrial Corporation. Die cast enclosed switches, explosion and splash-proof switches, limit switches and basic switches are covered. Each type is illustrated by design drawings and photographs and identified as to types of suitable applications. The last page shows typical uses for the basic switch.

30. Hydraulic Unit . . . The Model 301 "Midget" hydraulic unit produced by John Dusenbery Co. is described in detail in a leaflet now available from this company. This lightweight hydraulic unit consisting of pump, reservoir, relief and check valve and electric motor can be used as a substitute for compressed air, as remote control for hydraulic cylinders and for other similar applications. It is designed to fit in close quarters. Temporary or portable installations can plug into a 110 or 220 volt outlet and produce pressures to 1000 psi.

31. Steel Fittings . . . The Weatherhead Company reviews its line of Ermeto steel fittings in Catalog E-402-A. Designed for high pressure and excessive vibration, these fittings hold their air-tight, pressure-tight seal beyond the burst strength of the tube itself. They can be used on any type of rigid tubing and can be fitted quickly and easily with no special tools required. Available in all types of fittings in sizes from ⅛ to 1½ in with special adapters allowing for any type of reducer combination or line reduction. Design drawings are used

(Continued on page 38)

Post Scripts of Industry

NEWS · VIEWS · TRENDS

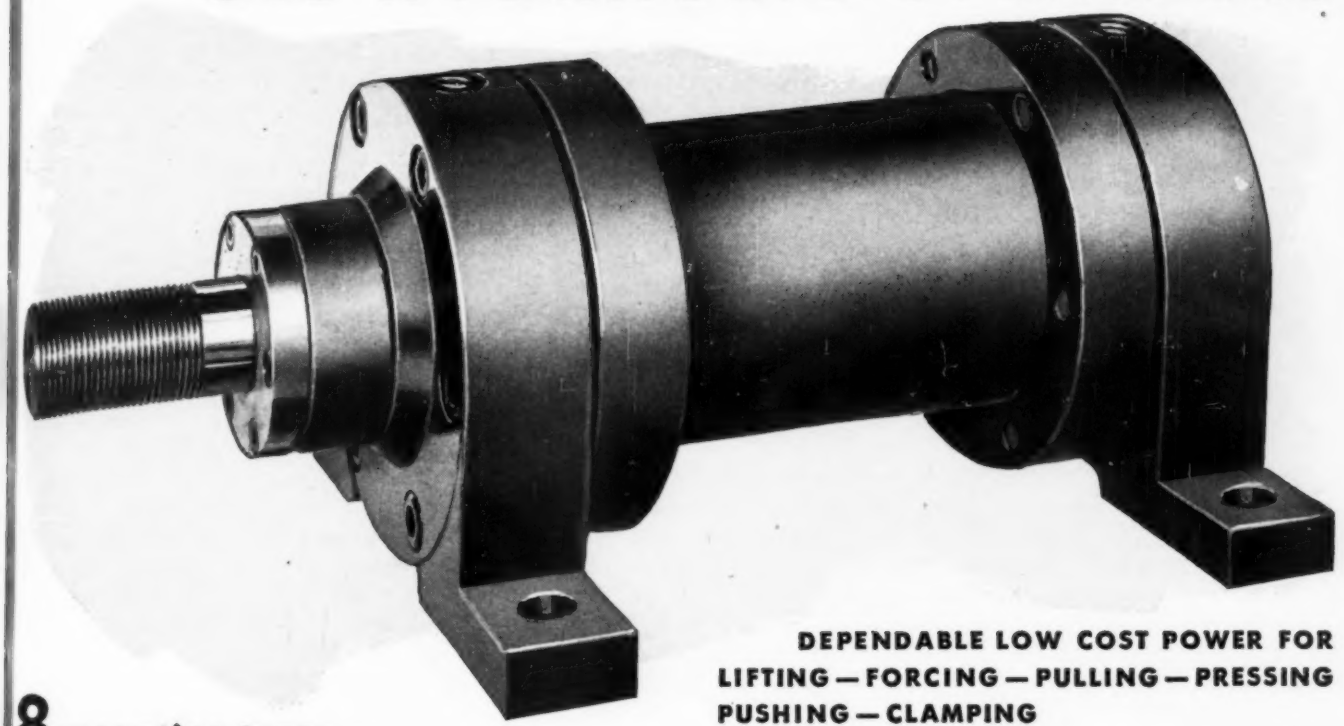
Gerotor May Corporation, Baltimore, Md., manufacturers of air and hydraulic devices for industrial application, has appointed the MacMillan Engineering Corporation, Chicago, Ill., as sales representative for the company.

Aero-Coupling Corp., Burbank, Calif., is operating under a license issued by Aeroquip Corp., Jackson, Mich.

Marvel Engineering Co. has moved into larger quarters at 625 W. Jackson Blvd., Chicago. The move provides five times the space previously occupied

(Continued on page 39)

LINDBERG
OIL HYDRAULIC CYLINDERS



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Check these many desirable features:

Lindberg Oil Hydraulic Cylinders are manufactured in 10 standard bore sizes from 2" to 8" inclusive.

Lindberg Hydraulic Cylinders are *both* bored and honed,—for easier operation,—and a more perfect seal between piston ring and cylinder wall. Tubes are of seamless steel.

Ports can be easily and quickly repositioned to suit your particular application. Just loosen cap screws, and revolve head cap. This feature permits simplified piping,—often eliminates need for T-fittings or elbows.

Caps, flanges, cylinder tubes, piston rods, and C-rings of all-steel construction reduce breakage,—minimize maintenance costs.

Pistons are of wear resisting Meehanite.

Step seal piston rings insure a more perfect seal.

High tensile strength alloy steel piston rod, turned, ground, and polished, reduces friction and wear on piston rod packing.

Lindberg also supplies:

—*cushion* type hydraulic cylinders.
—*water* hydraulic cylinders with bronze pistons, bronze rings, stainless alloy piston rods, cadmium plated caps, and chrome plated tube surfaces.
—air cylinders,—cushion or non-cushion type.

Chevron type piston rod packing is made of special asbestos cloth and rubber compound,—resists high temperature,—is not affected by oil.

Extra long bronze guide bushing eliminates piston rod sag,—minimizes wear on both rod and bushing.

Neoprene O-rings replace conventional gaskets. Sealing action is automatic,—the higher the pressure, the tighter the seal.

Socket-head cap screws are of cold drawn, heat treated alloy steel. "Pickup" and "freezing" in assembly is eliminated. Screws are easily removable for disassembly.

All screw heads are in the open and easily accessible from outside of cylinder. It is never necessary to partially disassemble cylinder to tighten screws.

C-ring construction eliminates necessity of tie-rods,—reduces installation space required.

Lindberg Oil Hydraulic Cylinders are designed and manufactured to operate at 1500 P.s.i. working pressure.

Lindberg Hydraulic Cylinders undergo 23 factory inspections, and are rigorously tested at pressures in extreme excess of the 1500 P.s.i. rating.

Write for bulletin 700, "Lindberg Oil Hydraulic Cylinders."

Lindberg Engineering Company, Air and Hydraulic Division, 2441 West Hubbard Street, Chicago 12, Illinois.

LINDBERG OIL HYDRAULIC CYLINDERS

throughout and special sections on tubing selection and fitting assembly recommendations are included.

32. Air Compressors . . . Catalog and Sales Manual No. 35 describes the single-stage and two-stage air compressors produced by Brunner Manufacturing Company. The single stage units are set for 150 psi and the two stage units for 175 psi. Both types are available in several different types of mountings with electric or gasoline power plants. Simple compressors and accessories are also shown in addition to several sections on engineering data.

33. Oil Coolers . . . Young Radiator Company reviews in Catalog No. 148 the heat transfer products they manufacture. Of special interest are oil coolers for torque convertors on portable or stationary installations. Two types are made—tube bundle and tube and fin. Commercial, industrial, automotive and aeronautical heat exchangers are included in this catalog with design and application illustrations used throughout.

34. Control Units . . . Bulletin No. 104 issued by Askania Regulator Co. reviews the pressure and flow, ratio and proportioning regulators, power pack, jet pipe power unit, electronic servo system and transometer signal and adjusting systems offered by this manufacturer. Some attention is also given to straight and crank type control cylinders and to standard regulator mounting panel boards. The bulletin also contains a description of the jet pipe principle used in all of the regulator equipment they produce.

35. Pneumatic Cylinders . . . The single and double-acting, nonrotating air cylinders offered by James L. Entwistle Co. are described in Catalog 20A. They are available in standard stroke sizes from 1½ to 10 in in any stroke specified. Four standard mountings are offered with cushioning supplied on either one or both ends. Design drawings and specification charts are included in this catalog.

36. Hydraulic Presses . . . Two new bulletins describing the hydraulic presses produced by The Baldwin Locomotive Works are available. Bulletin 285 of 12 pages, describes the miscellaneous types of presses in capacities ranging from 100 to 6000 tons for high speed production. Bulletin 286 also of 12 pages shows the standard and custom built steam platen presses offered. Photographs and specifications are used extensively in both bulletins.

37. Air Valves . . . A. W. Cash Valve Manufacturing Corporation recently released Catalog D-14 covering their pressure reducing valves, strainers, relief valves and controls for air and water service. This equipment is chiefly of the low pressure type and best suited for air service as the operating pressures range to only 150 psi. Design and detail drawings, specification charts and application data are included.

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The Amazing New

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Synclinal Filter

Designed especially for

HYDRAULIC EQUIPMENT

Because of its ability to filter out minute particles of foreign matter and still operate at full capacity at less pressure loss, the Marvel Filter is truly a life saver for all hydraulic equipment. It offers a filtering area equal to 3 like size units, therefore, allows machines to operate for much longer periods before cleaning is necessary. The simplicity of its construction and the ease with which it can be replaced makes the cleaning period a matter of minutes.

NOW AVAILABLE IN SIZES RANGING IN CAPACITIES FROM 5 TO 50 GALLONS PER MINUTE

All Marvel filters can be furnished with various size mesh screens with openings from .0029 to .0198 or 200 mesh to 30 mesh. The versatility of the Marvel Synclinal Filter and how it can meet the exact requirements of your filtering needs whether they be for hydraulic machines, Coolant Systems or other oil-circulating machinery along with complete engineering data are outlined in Free Booklet No. 103. Send for your copy today.

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CHECK VALVE

Take advantage of our wide selection of pressures and deliveries to fit specific application.
Why waste power and money on flow controls to adapt larger, more costly units to small flow requirements.

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and is the third expansion of the company since 1943.

John S. Barnes Corp., Rockford, Ill., manufacturer of hydraulic structures, pumps, controls and fluid power units, has appointed Nielsen Hydraulic Equipment Inc., New York, as its representative for eastern New York state and metropolitan New York.

Economy Pumps Inc., Hamilton, Ohio, has appointed Dinham Co., Minneapolis, as distributor.

Sperry Products Inc., is now in its new plant at Danbury, Conn. The move was made from Hoboken, N. J. to provide necessary additional space for the manufacture of hydraulic remote controls and other control devices.

Mead Specialties Co., Chicago, has appointed the R. M. Wright Co. of Detroit, Mich., and the Jackson-Walter Co., of Philadelphia, Pa., as representatives for the company's line of air cylinders, work-feeders and other air-operated devices.

PERSONALS

HOWARD STEVENS has been appointed manager of industrial sales promotion by Saval Inc., Los Angeles. Mr. Stevens formerly was northeastern section representative for Watson-Stillman Co.

E. W. CHAPMAN was named vice president in charge of engineering of Tuthill Pump Co., Chicago, on September 1.

FRED L. WHITE has been named development and consulting engineer by Osgood Co., Marion, Ohio. His former position as chief engineer will be filled by JOHN E. CALLOUETTE.

LOUIS W. MASON has been appointed assistant to the general manager of sales, National Tube Co. He was Pittsburgh district manager of sales.

JOHN H. MATTHEWS, vice-president and director of Raybestos-Manhattan, Inc., Passaic, N. J., has been elected to the board of the Canadian Raybestos Co., Ltd. Mr. Matthews joined Raybestos-Manhattan in 1914 and is now in charge of the Manhattan Rubber Division at Passaic.

F. A. SCHICK has been appointed chief engineer of the Springfield, Ill. works of Allis-Chalmers, succeeding A. C. BOOCK who was advanced to general manager of that plant.

HAROLD T. ANDERSON has been named assistant to the general sales manager of the Worthington Pump and Machinery Corp. He was advanced from manager of sales production relations.

LET US RECOMMEND

The specific metal best suited for each of your particular parts — the best location for oil grooves, etc.

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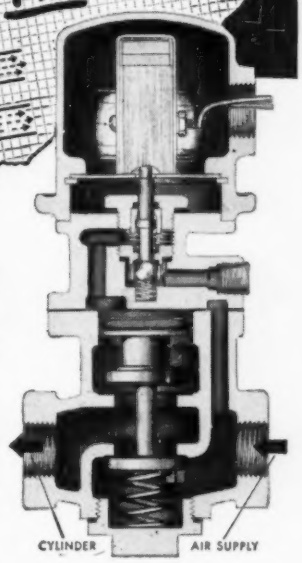

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LOW INITIAL AND OPERATING COSTS

Ross-In-Line valves solve your "on-and-off" problems. Provide instant shut-off, plant-wide or a single coolant line . . . or split-second control of a single acting cylinder. Air controlled, pressures to 125 p.s.i. . . . air, liquid, gas. A *better* job at lower cost.

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Designed and built to *stand up*; Hycar seals, naval brass and stainless steel parts. Specifically for efficient air operated control, straight-way and 3-way, normally open or closed, ¼" to ¾" pipe capacity.

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Solenoid-Pilot Sections interchangeable on all 16 Ross-In-Line Bodies

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G. L. HARMON, JR. has been appointed manager of the Milwaukee branch office by Bailey Meter Co., Cleveland. Mr. Harmon formerly served his company in their Los Angeles office. On his staff J. L. ANDREWS will serve as mechanical engineer and L. O. SMITH as service engineer.

WALTER GEORGE WHEELER has been named as chief engineer of the Hufford Machine Works, Inc., Redondo Beach, Calif.

EDWARD B. LANG has been appointed advertising manager by Sperry Products Inc., Danbury, Conn. He came to Sperry from the Public Relations Department, General Electric Co.

RAY R. WEST has been named manager of sales for products used in industrial applications by Minneapolis-Honeywell Regulator Co., Minneapolis. Mr. West will make his headquarters at the Brown plant in Philadelphia.

J. E. CROTTY has been appointed sales engineer for Aetna - Standard Engineering Co., Youngstown, Ohio.

A. L. HAWK has been appointed assistant to the western district manager by Raybestos-Manhattan Inc. with headquarters in Chicago. Mr. Hawk's vacated position as manager of distributor sales of the western district will be filled by R. B. HAZARD, formerly of the Minneapolis territory.

JOHN E. ROWE has been named plant manager of the Ross Operating Valve Co., Detroit.

W. G. TAPPING, Los Angeles district sales manager for Cutler-Hammer Inc., has been appointed manager of the West Electric Products Co., Los Angeles, recently acquired by Cutler-Hammer.

WILLIAM ARTHUR has been named manager of a new mid-Atlantic sales region of the general machinery division by Allis-Chalmers Mfg. Co. with headquarters in Philadelphia.

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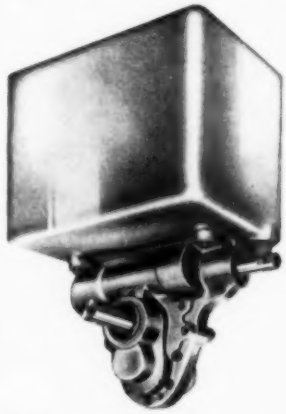

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